JPRS 71834

8 September 1978

USSR

TRANSLATIONS ON USSR SCIENCE AND TECHNOLOGY
PHYSICAL SCIENCES AND TECHNOLOGY
No. 48

U. S. JOINT PUBLICATIONS RESEARCH SERVICE

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CONTENTS

COMPUTER SYSTEMS IN NATIONAL ECONOMY

Moscow EKONOMICHESKAYA GAZETA in Russian No 31, Jul 78 p 15

/Article by USSR Minister of the Radio Industry P. S. Pleshakov: "Equipment of Computer Technology"/

/Text/ We continue the publication of articles on the materials of the Second All-Union Conference on the Use of Computer Technology and Automated Control Systems in the National Economy (the preceding articles were published in Nos 22, 23, 24, 25, 26 and 29).

On the Basis of a Single Series

Jointly with the countries of the socialist community the development of a single series of computers and the conversion of production to the output of third generation computers were completed by 1975. During the years of the Tenth Five-Year Plan the production volume of the equipment of computer technology will increase in the USSR more than 2.5-fold. The structure of the computers being produced is changing qualitatively. Whereas in 1975 the R-20 computer with an operating speed of 20,000 operations a second was the most popular, now the R-22 is the most popular. It has an operating speed of about 100,000 operations a second, and its cost with respect to the R-20 virtually did not change. On the average the units comprising the working storage increased threefold, the capacity of the magnetic disc file increases several times.

In connection with the substantial increase of the operating speed of the processors of computers the demand for peripheral equipment (disc and tape storage units, alphanumeric printers, plotters, remote-controlled processing equipment and others) increased sharply. Therefore the production of peripheral units and terminal equipment of both the computers being produced and the computers previously produced is being developed at an anticipatory rate.

At present the fulfillment of the program of the development of the hardware of the first section of the YeS EVM /Unified Computer System/ (Ryad-1) has

practically been completed. The hardware of the second section of the YeS EVM (Ryad-2) includes program-compatible computers and more than 30 types of peripheral equipment. The use of integrated memory circuits was an important factor here.

All the computers of the section are distinguished from their first "sisters" by an improved logical structure and by higher technical parameters. In the new models of computers the modes of operational and dialog control have been implemented to a greater extent, a higher speed of the exchange of information is provided.

The state tests of the computers of the second section, which were carried out according to an extensive and complicated program, showed that the set technical requirements had been completely met. The high-order model of this section--the R-65 computer, the development of which is being completed, in its technical parameters is on a par with such now productive foreign computers as the IBS-3033, the Amdal-470/6 and the Fujitsu M-190.

There have also been carried out state tests of the YeS-7920 display station, which ensures work in various configurations which include displays and sequential printers in both the local and remote variants.

It is especially necessary to speak about the possibilities of the equipment of the second section in the area of the organization of collectively used systems. The computers of the first section had restrictions for the construction of such systems. Now the hardware and software make it possible to create collectively used systems which operate in different modes. For this purpose a special operational system was introduced, which is designed for the modes of time sharing and the remote-controlled processing of data.

The further development of the YeS EVM Ryad-2 will take place by means of the development of two-computer and two-processor packages and the switch to single computers and packages of specialized processors, which substantially increase the operating rate of these packages during the solution of problems of specific classes. This direction of the development of the hardware of the unified system is being carried out within the framework of the plan of Ryad-3, during the implementation of which a new element base and new architectural principles of the construction of computer systems on the already existing element and design-technology base are being developed and introduced simultaneously. The computers being developed in this case will have a developed logical structure which makes it possible to connect up special processors (matrix, symbol and others), to integrate and operate in computer systems.

At the same time work is being carried out on the development of multiprocessor computers of superhigh productivity. There has already been produced a pilot batch of El'brus-1 multiprocessor computer packages which have been built according to the modular principle which makes it possible to gradually increase the productivity of the packages by means of an increase of the

number of processors (from 1 to 10), the increase of the capacity of the operational storage and the substantial enlargement of the capacities of the files. The productivity of each processor of the package is in excess of 1 million operations a second, and with a 10-processor package it is up to 12.5 million operations a second with efficient operation in high-level languages. The further development of the principles incorporated in it made it possible to develop and shift to the introduction in production of the El'brus-2 multiprocessor computer package with a productivity in excess of 100 million operations a second.

Centralized Computer Maintenance

Of great importance for increasing the efficiency of the use of computer equipment is its comprehensive centralized maintenance which includes the performance of such jobs as the installation, adjustment and placement into operation of hardware, the placement into operation and follow-up of the operational systems and packages of applied programs, the warranty, post-warranty and preventive maintenance and repair of the equipment put into service, the training and retraining of the operating personnel for the users of computers.... Such maintenance of computer equipment makes it possible to cut at enterprises and organizations having them a considerable number of service personnel, to substantially reduce the number of expensive and scarce spare parts and units, to decrease the time and expenditures connected with the training and retraining of such specialists, to increase the rate of use of computer time. The saving from the use of the centralized maintenance of computer equipment during the Tenth and Eleventh Five-Year Plans may be many hundreds of millions of rubles.

The implementation of the functions of comprehensive centralized maintenance has been entrusted to the created all-union association, which is called upon to solve problems of a production, scientific, technical and educational nature, as well as to implement interaction on questions of such maintenance of the equipment of the YeS EVM with the corresponding national organizations of technical maintenance in the socialist countries participating in the community in the area of computer technology. At the basis of the organizational structure of the association is the territorial principle which makes it possible to bring the maintenance centers as close as possible to the users of computers. The technical maintenance stations and regional service centers are being organized in cities having more than five computers. Now service centers and stations have already been set up in 43 cities of the country.

The two years of activity of the mentioned association have made it possible, in particular, to organize mobile technical repair workshops and mobile software laboratories, to develop an automated system of instruction of the users of the YeS EVM with the use of series-produced hardware of computer technology and to begin the work on the tie-in of the plans of the computer center to the facilities of the users.

The training and retraining of specialists were carried out at educational centers of the association in 65 specializations which embrace instruction on the hardware of the YeS EVM and software. The period of instruction depending on the specialization is from two to four months.

In spite of the considerable rate of development, the association is still not able to meet the growing needs of the users. Above all this pertains to the acceptance of computers for maintenance, the deliveries of documents on the base software and its follow-up, and the training of specialists.

Measures are being taken to overcome the shortcomings in this matter. It is necessary, however, to bear in mind that a large number of organizations and enterprises of many sectors of industry are taking part in the development and production of computer equipment. Therefore the efforts of the ministry should be supported by the timely fulfillment of their sections of the work on the part of all the participants in the development of equipment and systems and by the allocation of the necessary capital investments by USSR Gosplan.

The Improvement of Automated Control Systems

As to automated control systems the work here is being carried out in the direction of the development of sectorial automated control systems (OASU's), which are intended for use on the part of the ministries and main administrations, automated control systems of enterprises (ASUP's) and, finally, automated control systems of technological equipment and processes (ASUTP's). The coordination of their development and introduction in the group of ministries is being carried out by the Interdepartmental Council made up of the first deputy ministers. An intersectorial fund of algorithms and programs has been set up for the organization of the effective exchange of programs between the sectors of industry.

The OASU's in the sectors of industry are being developed as integrated systems which embrace all the levels of administration and are based on a unified methodology, interconnected software and hardware. By using standard plans of sectorial systems and the subsystems included in them, there are being solved here on computers problems which concern planning, economic and financial administrations, administrations of material and technical resources and the making of sets for marketing, the chief engineer and the chief power engineer, as well as production control and day-to-day management of the sector.

The subsystem of optimum planning, which ensures the shift from the formed level of the organization of production to the optimum level, is the most important component of the comprehensive system of control of the sector. The system of optimum variants is the basis of the optimization of the organization of sectorial planning. There have been introduced in the planning estimates standardized methods of the formation of the volume, assortment, economic and capacity indicators, which are based on the standards of the capital-labor ratio and the output-capital ratio, the use of

the capacities and equipment, the structure of the number of industrial personnel engaged directly in production, the decrease of the labor-intensity and production cost of items and others.

Alma-Ata. The second section of the automated control system is being prepared for operation at the control post of the united power system of Kazakhstan. In the photograph: senior engineer T. Koval' and computer sector managers V. Bekirov and T. Tadzhiyev carry out the check-out of programs at the control post of the ASU.

In the radio industry, for example, the first section of the standards, which have been introduced in the subsystem of sectorial planning, numbers about 50 groups of indicators. Unified forms of planning and reporting documents have been developed and introduced at all levels--the enterprise, main administration, ministry. These forms, which were arranged according to a common methodological principle and have a uniform structure, embrace the sections: "Production Development," "Economic Indicators," "The Development of Capacities" and others.

The implementation of the measures of the first stage of optimum planning made it possible to shorten the term of the drafting of the sectorial

plan of production, to develop a unified system of indicators, forms and methods of the calculation of plans, reports and the analysis of the work of enterprises and on this basis to ensure the adoption and implementation of stepped-up plans. For the purpose of the increase of the efficiency of the control over the fulfill of the plans of production on the most important products list, administrating accounting and the analysis of deviations from the normal course of their fulfillment and adoption in connection with this of the appropriate operational decisions, as well as the accounting and regulation of the supply of production with scarce material resources, there is in operation in the sector a subsystem of operational control on the basis of an automated information control post, which has a direct link with the information posts of the plants.

By 1975 there had been completed the drafting of standard manufacturing plans of the ASUP's of multiproduct, mass and small-series production, which have become widespread in the sectors of industry.

In 1976 a check was made of the efficiency of the ASUP's at many diverse enterprises. It revealed both the sources of efficiency and the causes of shortcomings in the organization of the development and introduction of automated control systems. The analysis of the operation of the ASUP's showed that the greatest economic impact comes as a result of the raising of sets of problems, which are connected with the technical preparation of production, the day-to-day management of its process, the optimum technical and economic planning, material and technical supply, above all at large industrial enterprises with a large products list and the frequent interchangeability of the items being produced.

Typification, unification and standardization of the elements of ASU's, subsystems and systems raised for developers many problems which it was not yet possible to completely solve during this period of time. It was possible to achieve the greatest typification in the technical composition of the equipment, software, information and organization support. It was possible to typify the functional problems of control only for identical industrial enterprises. Therefore a unified standard automated system cannot be completely used. The further improvement of the systems is being carried out with allowance for the gained experience and on the unified base of the hardware of the YeS EVM. The coordination of this work is being carried out within the framework of the council of chief designers and the mentioned Interdepartmental Coordination Council of the group of ministries.

During the Tenth Five-Year Plan the work connected with two important things was developed extensively. The first is the shift to an improved and more promising base--the YeS EVM, and the second is the shift to the fulfillment of individual assignments on the processing of data and estimates for the overall solution of the problems of the development and improvement of production.

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DEVELOPMENT OF SOVIET COMPUTER SYSTEMS

Moscow VESTNIK STATISTIKI in Russian No 6, 1978 pp 48-55

[Excerpts from article by N. Ivanov, deputy chief of the Main Administration for Computer Operations of the USSR Central Statistical Administration, and V. Zav'galov, chief of the Department for the Automated System of State Statistics (ASGS) of the Main Administration of Computer Operations of the USSR Central Statistical Administration: "Stages in the Creation of the Technical Base of the Automated System of State Statistics"]

[Excerpts] In terms of its technical equipment, the ramified structure of its network of computer-information centers and stations and the level of development for the technological procedure of data processing, the computer system of the USSR Central Statistical Administration is one of the most important in our country's national economy.

From 1958 through 1971 about 30 computer centers based on second-generation computers of the "Minsk" type were organized within the USSR Central Statistical Administration system. During these years experience in computer operation and the creation of software has been accumulated, qualified teams of programmers and specialists in the technical servicing of computer technology have been trained and means for the most efficient organization of computer center operation have been determined. In addition, machine programs and manufacturing plans for the computer processing of statistical accounting have developed locally by each computer center individually. A whole cycle of processing within the framework of a single computer center has been provided for by manufacturing plans, from the preparation of technical carriers to obtaining the resultant reference-classification tables. This frequently has led to the creation of insufficiently efficient manufacturing plans, duplication of operations and the impossibility of uniting the separate computer centers into a single computer center.

The first attempt at organizing systems processing was undertaken in 1969-1970 during the development of current accountability for the statistics of population budgets with computers. This method obtained wide propagation at the third stage of development of the USSR Central Statistical Administration computer system which was connected with the creation of the first line of the

Automated System of State Statistics and its technical base, the wide application of systems processing of statistical information on second-generation computers, the beginning of fitting out and assimilating third-generation computers, the completion of the organization of computers on the oblast' level and the development of the technical base for the rayon level.

The first line of the Automated System of State Statistics which was created in 1970-1975 provided for systems processing on computers of the most important and laborious statistical accounts, which comprised more than half of the total volume of statistical operations being done in the Central Statistical Administration system. Processing time was decreased, the reliability and the degree to which the resulting data could be analyzed was increased, and the cost of the number of operations was decreased. Aside from the statistical developments, we completed the mechanized and automated processing of accounting and other economic information of various establishments and organizations in the national economy as well as in ministries and departments with which agreements were reached on the use of the technical base of the Automated System of State Statistics for these purposes.

The creation of the technical base of the first line of the Automated System of State Statistical demanded a large amount of work from the USSR Central Statistical Administration system on expansion and strengthening, as well as on the creation of new and the completed equipping of existing computer and machine calculating centers. Proceeding from the problems posed during this period and the available possibilities, the technical base of the state statistics system at the union, republic, and oblast' levels were equipped with "Minsk-32" computers, the computer information centers in the rayon unit and some computer centers of oblast' statistical administrations were outfitted with the M-5000 computer perforation complex, and information and computation centers of the rayon-level Automated System of State Statistics with the Tsellatron "S-8205M" electronic account automation.

The first line of the Automated System of State Statistics made wide use of electronic multi-counter bookkeeping machines, "Askot-70s" with perforating attachments. These machines were used to process small volumes of information on uncomplicated algorithms with the simultaneous receipt of perforated tapes for subsequent processing on computers. They were also used as devices for preparing data on perforated tape. They were particularly widely used at the rayon level to process statistical accounting.

One of the crucial problems in the third stage of the development of the Central Statistical Administration USSR computer system was automating the processes in long-distance information exchange. For the purposes of decreasing the time for transmitting and processing statistical accounting, raising its reliability and automating the processes in long-distance information exchange, the "DFE-550" type, medium-speed apparatus for data transmission was introduced into the first line of the Automated System of State Statistics. At present, the State Computer Center of the USSR Central Statistical Administration, all republic computer centers of the union republics, and 80 computer and machine calculating centers in oblast' statistical administrations have been equipped with this apparatus.

Practice has proven that the change from using a subscriber telegraph network to the medium-speed data transmission apparatus significantly decreases data transmission time and payment expenditures for communications channels. Simultaneously with this, the number of errors during statistical accounting transmission is decreased to as few as one per one million digits, whereas on the teletype, for example, one error occurs approximately per 1-10 thousand digits. The use of the data transmission apparatus gives us the possibility of increasing the speed of data transmission 5-10 times in comparison with the subscriber telegraph network. Presently, the "DFE-550" operates in both "tape-computer" and "computer-computer" modes.

Included in the complex of technical means in the third stage are those for duplicating and registering documents. The means of duplication depend basically on the time for completing operations, on the format, on the size of the printing and volume of documentation. To prepare a comparatively small number of document copies (up to 25 copies), electrographic, stencil, and hectographic printing equipment is, as a rule, used. For a larger number offset equipment is used. The "Romayor" and "Rominor" machines from the Czekoslovak SSR are being used for duplication by this means in the Automated System of State Statistics.

At present, documentation is duplicated by electrographic and stencil means at the computer and machine calculating centers of the Central Statistical Administration USSR system. To complete copying operations by these means, planar-type electrographic copying apparatus (ERA-M, ERA-2, EP-12RM-2), rotation-type electrographic copiers like the REM 420/600, "Xerox" (England), and "Tsiklos" (Czekoslovakia), and rotary presses are used. For registering statistical documents offered by administration and planning organs, brochure-binding equipment collating devices, stapling machines, paper-cutting equipment, box-cutting machinery, book-binding presses and other machines are used.

As a result of the work carried on during the 9th Five-Year Plan, 76 new computer centers of statistical administrations in the oblast's krays, and Autonomous Soviet Socialist Republics were organized, and more than 1500 new rayon (urban) machine calculating stations were created which, in the future, will be changed into computer-information centers and stations. The computing capacities of the USSR Central Statistical Administrations system have increased from 0.4 million operations per second (1971) to 3.6 million operations per second (1975).

The technical base of the first line of the Automated System of State Statistics at the beginning of the 10th Five-Year Plan was composed of: two union-level computer centers, 15 republic computer centers, 125 oblast'-level computer centers, and 171 state computer-information centers, as well as 2500 state computer-information stations and machine calculation stations on the rayon level.

The fourth stage in the development of the computer system is connected with the creation of: a technical base for the second line of the Automated System

of State Statistics; a computer center network based on the introduction of teleprocessing equipment and intercenter data transmission; and the first experimental collective-use computer centers, as well as with the completed outfitting and wide use of the Unified Computer System, the continuation of work on building computer installations (rayon machine calculation stations, computer-information stations, and computer-information centers) at the rayon level, and the creation of experimental automated data banks. The second line of the Automated System of State Statistics is basically oriented to computers in the Unified System.

For the purposes of creating the technical base for the second line of the Automated System of State Statistics, the State Computer Centers of the USSR Central Statistical Administration must be completely equipped with two or three ES-1040s (a product of the German Democratic Republic), which function as a single, powerful computer complex; the Central Computer Centers of the USSR Central Statistical Administration with several ES-1022s and two or three high-capacity computers for processing the materials of the All-Union Population Census for 1979; and about 60 of the largest computer-centers from the statistical administrations of the Autonomous Soviet Socialist Republics, krays, and oblast's with ES-1020 (1022) class machines. In addition, this year the republic computer centers in the Unified Computer System will be completely outfitted. All of the indicated measures will give us the potential by 1979 of introducing extensively introducing systems technology for processing statistical accounting on the basis of third-generation computers.

In the near future work will begin on the transfer of the electronic data processing complexes with "Minsk-22" computers that have already been introduced to the Unified Computer System. A number of electronic data processing complexes used with "Minsk-32" computers are also designated to be transferred to the Unified Computer System. A number of them will be developed jointly on the "Minsk-32" and different types of Unified System computers through the transmission of results on magnetic tapes and along communications channels. To do this, it will be necessary to develop programming and technological methods of using the data files on the magnetic tapes of "Minsk-32" computers for the Unified Computer System.

The creation of a technical base for the Automated System of State Statistics offers the possibility of expanding the volumes and improving the quality of the operations being done for different ministries, departments, establishments, and organizations in the national economy. More than 20 organization automated control systems and about 30 establishment automated control systems are already using the technical base of the Automated System of State Statistics to solve problems in operations and technical/economic planning, accounting, and statistics. The USSR Stroybank (All-Union Bank for the Financing of Capital Investments) and many of its republic, oblast' and urban offices use the technical base of the USSR Central Statistical Administration system. The Stroybank automated control system being created will, in the future, be completely based on the computer centers and stations of the USSR Central Statistical Administration. At present, of 585 Stroybank offices and departments, 483 have been accepted for services by the computer centers and machine calculating stations of that Administration.

Work has been widely developed on the design of an Automated System of Financial Accounting. The main organization in the design of this system is the High State Planning and Technological Institute of the USSR Central Statistical Administration, while the methodological direction for its design and its tie-in with the Automated System of State Statistics is being undertaken by the Scientific Research Institute of Finance of the same Administration. At present, a number of design materials for the creation of the Automated System of Financial Accounting have been developed.

As the technical base of automated production accounting systems at the oblast' (Autonomous Soviet Socialist Republic, kray) and rayon (city) levels, computer centers and stations of state statistics will also be used to conduct the necessary plan estimates and to process economic information for planning agencies.

Along with the development of the service of functional and sector automated systems, we will expand, on the basis of the Central Statistical Administration's computer system, the introduction of the complex mechanization of accounting for individual establishments and organizations, including those in the framework of automated production control systems being created. Here, special attention is being paid to the introduction of the complex mechanization of accounting at accounts departments, kolkhozes and sovkhozes. For the purpose of further developing the complex mechanization of accounting in the national economy, extensive training of teams is being conducted--specialists in agricultural accounting and its mechanization and workers in mass professions for computer centers and stations in the Central Statistical Administration. Work is also being conducted on improving the state of bookkeeping on kolkhozes and sovkhozes and preparing computer centers and stations for the implementation of the complex mechanization of accounting. All the work on introducing complex accounting mechanization at agricultural establishments is being carried on by means of unified methodological and design materials developed by the USSR Ministry of Agriculture and the USSR Central Statistical Administration on the basis of a model mechanization project on kolkhozes and sovkhozes with the use of computer perforation machinery. At present, the All-Union State Planning and Technological Institute of the USSR Central Statistical Administration is perfecting design documentation on the perforated-card complex M-5000.

In future years, the complex processing of accounting data from ministries and departments as well as establishments and organizations will obtain greater and greater relative significance in proportion to the development of the Automated System of State Statistics. A higher form of service is the display of information according to a previously agreed-to complex program and individual requests during the operation of collective-use computer centers based on third-generation computers under time-sharing conditions and using an ABD [automated data bank]. This form is especially important because it offers not only technical service but also a deeper use of data accumulated in the Automated System of State Statistics and their complex processing, which in the future will become a most important factor in the efficiency of the Automated System of State Statistics.

The USSR Central Statistical Administration computer system, which operates on a cost-accounting basis, to a large extent is already fulfilling the functions of a collective-use system, processing the accounting, statistical and other economics information of about 75 thousand establishments and organizations. Here, basically, second-generation computers are being used, which places certain restrictions on the composition of the problems being solved, the types of information service, and the volumes of computer operations being done. Nonetheless, the accumulated practical experience in the operation of the Central Statistical Administration computer system and the problems prepared serve as a good basis for further theoretical developments and experiments in creating more perfect collective-use systems using computers of the third and subsequent generations operating under time-sharing conditions.

In developing the above-indicated computer system the necessity should be kept in mind of creating a system of territorial collective-use computer centers that are meant, along with processing statistical information, to do computer operations according to orders from establishments, organizations, administrative agencies and their automated control systems. The territorial collective-use computer centers are designed to solve the following most important problems: information service to establishments and organizations on the basis of creating and introducing both a territorial automated data bank which would interact with those of other territories and automated systems for various purposes; information service and accomplishment of computer operations for territorial planning and administration agencies, including those on problems from their automated control systems; the accomplishment, according to the automated production control system program, of operations for establishments and organizations distributed in a given territory having their own technical means for data processing; and large-volume problems connected with the use of data from territorial automated data banks and which also do not have their own technical base for data processing.

The creation of collective-use computer centers will help significantly to raise the intensity of computer use in the national economy through the great concentration of computer capacities in these centers, decreasing by approximately twice the expenditures for creating and operating the automated control systems and computer centers.

In the USSR Central Statistical Administration system experimental collective-use computer centers will be created on the basis of republic computer centers of the Belorussian and Estonian SSR's and the computer centers of the Statistical Administration of the Tomsk oblast' and the Tula oblast' computer center of State statistics with the use of ES-1033 computers. In the future, it is obvious, they will be re-equipped with high-capacity computers (of the ES-1035 and ES-1060 type) and changed into experimental-index centers.

The presence of an extensively developed and technically equipped system of computer centers requires the unification of their functional structure. In connection with this, it is advisable to examine briefly what is the standard functional structure of computer centers at different levels of the Automated System of State Statistics.

The Computer Center: Standard Functional Structure

All computer centers in the USSR Central Statistical Administration system were formed on the basis of machine calculating stations. All of them are independent cost-accounting organizations which are directly subject to the corresponding statistical administrations. They implement the accumulation, development and output of statistical data in the volume and periods of time established by the plan for statistical operations and by the individual commissions of the statistical administrations. They also provide for the reliability and completeness of the statistical information being produced, for improving quality, decreasing time, decreasing the cost of developing the statistical data and participating in work on the creation, start-up and efficient functioning of the Automated System of State Statistics, as well as for the automated and mechanized development of accounting and reporting and other documentation for ministries, departments, establishments, organizations and institutions on the basis of economic agreements, etc.

In connection with the creation and development of the Automated System of State Statistics, the problems of functions of computer centers become complicated. Thus, in creating this system in accordance with the Statute on Coordinating Work on the Creation of the Second Line of the Automated System of State Statistics for State Computer Centers, the USSR Central Statistical Administration is the leading organization in the creation of concrete programming (electronic information processing complexes). In this direction, the State computer center organizes the development and introduction of electronic statistical information processing complexes, and participates in the introduction of manufacturing plans for functional subsystems.

Here, the State Computer Center of the USSR Central Statistical Administration organizes the process of developing electronic statistical information processing complexes, implements quality control and promptness of the development of manufacturing plans and graphs, and controls the accomplishment of organization plans for using systems programming, the introduction of standard project decisions in the area of means for data preparation, the transmission of information along communications channels, methods of logic and arithmetic control, the registration of processing results, and other questions in the technology of processing statistical information.

The State Computer Center of the USSR Central Statistical Administration implements control over the time periods for developing specific programming. It controls and takes measures for the timely introduction of developed, concrete programming. It and the Republic Computer Center of the USSR Central Statistical Administration are the executors responsible for the unified programming of electronic information complexes. The coexecutors are the computer centers of statistical administrations in the autonomous Soviet socialist republics, krays and oblast's.

Computer centers at the republic and oblast' levels have basically been built according to a standard structure. A number of the computer centers have

changed the standard outline of their functional structure. Some of the most frequent changes are the following: the division of technical computer services has been transferred to the deputy chief of the computer center on mathematical methods, the division of computer operation to the chief engineer and the copying-multilith sector to the deputy chief of the computer center on statistics.

The advisability of these changes in the standard functional structure of a computer center largely depends upon its concrete conditions and, above all, on the qualifications of its personnel.

In the majority of computer centers the functional structure foreseen by the standard official instructions of the personnel at the computer center (machine calculating station) of the USSR Central Statistical Administration system was accepted without changes.

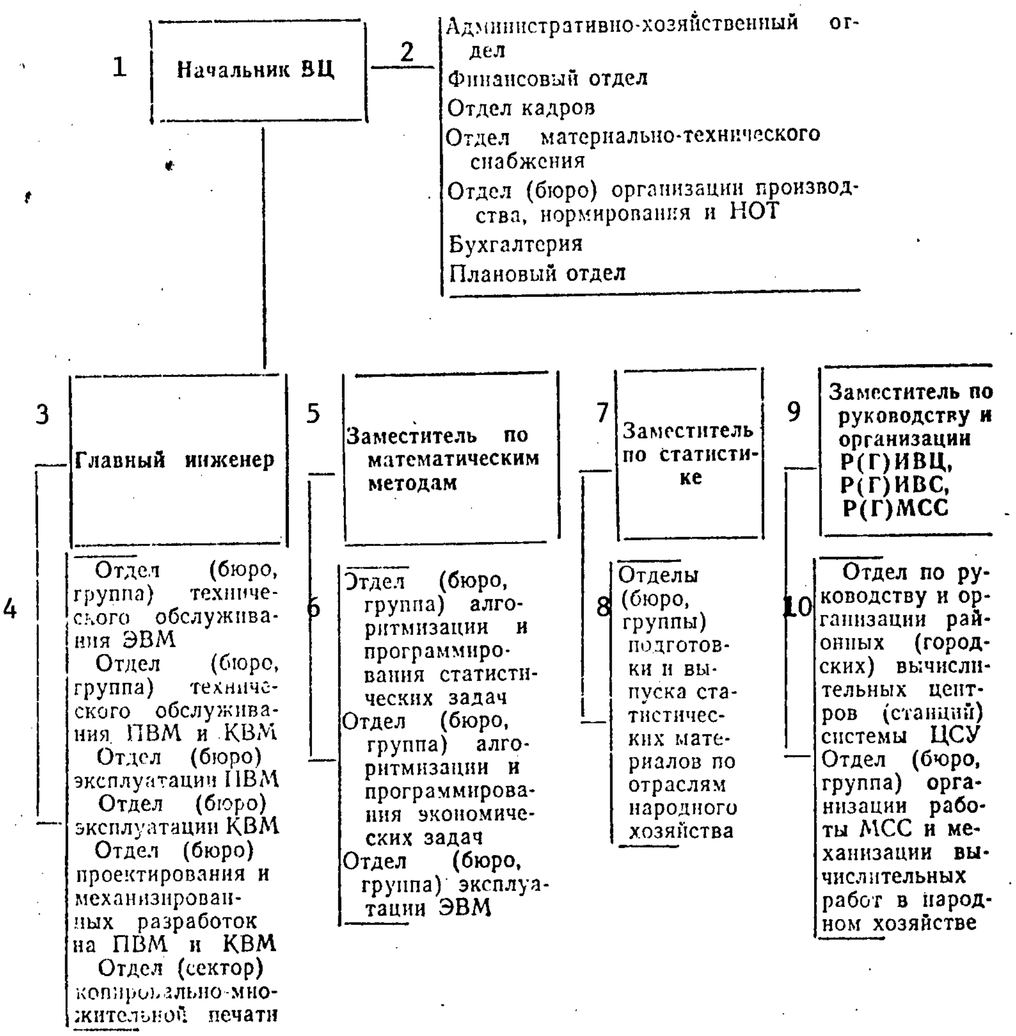
The further development of the Automated System of State Statistics calls for a change in the functional structure and the official responsibilities and rules as well as in the demands made on workers at the computer centers. The informational, technical, programming and methodological connections between computer centers are growing. With the further development of the Automated System of State Statistics system, the operations fulfilled within the framework of a single computer center should be curtailed; the operation of the computer center will more and more be carried out as a part of the all-union automated system. Even now, the absolute majority of statistical problems on computers at all the computer centers in the USSR Central Statistical Administration system are being solved according to a single type of programming for the system. Analogous work will be conducted also for systems customers (the Ministry of Finance, Stroybank, the Main Administration of State Insurance, agricultural establishments), which, of course, will be reflected in the structure of the computer centers. Experience in the construction of the first line of the Automated System of State Statistics has shown that there is no need to have decisions of algorithimization for the programming of statistical problems at all computer centers. It is more efficient also to centralize the forces of statistical problems programmers at several computer centers, having commissioned them to develop applied programming for the Automated System of State Statistics while having only a bureau at the other centers (3-5 people), who would implement the tie-in to local conditions and the introduction of an applied systems programming. It may be necessary not to have independent bureaus, but to bring the programmers into the make-up of operating departments.

In the course of creating and further developing the Automated System of State Statistics modern methods of collecting and transmitting information are being introduced extensively into the practice of statistical data collection and processing. Thus, the organization of a bureau of long-distance information receipt and transmission is possible. The function of such a bureau will include the receipt and control of information which comes to the computer center both through communications channels and on technical carriers, the processing

of such information carriers, providing for the timely transmission of data along communications channels to the higher statistical agency, and providing for the reliable operation of the data transmission apparatus.

It is possible to separate the bureaus of standards and reference information, the functions of which could be the storage and management of the territorial parts of the all-union classifiers and the reference-information fund, and the accumulation and systematization of standards, technical-economic, and other indicators necessary for completing the operations of the computer center. It is also possible to organize a magnetic library and a fund management bureau of magnetic carriers and programming. We should note that the functional structure of the computer centers in the USSR Central Statistical Administration system will change with the functions of collective-use computer centers.

A Standard Diagram of the Functional Structure
of the Computer Center
at the Republic and Oblast' Levels of the
Automated System of State Statistics



Key:

1. Director of computer center

2. Administrative-economic division
   Finance division

Personnel division
Division of material and technical supply
Division (bureau) of production and standardization, organization and the scientific organization of labor
Accounting department
Planning division

3. Chief engineer

4. Division (bureau, group) of computer technical service
Division (bureau, group) of punched-card and keyboard computer technical service
Division (bureau) of punched-card computer operation
Division (bureau) of keyboard computer operation
Division (bureau) of design and mechanization of developments on punched-card and keyboard computers
Division (sector) of copying and multilith printing

5. Chief of mathematical methods

6. Division (bureau, group) of algorithmization and programming of statistical problems
Division (bureau, group) of algorithmization and programming of economics problems

7. Chief of statistics

8. Divisions (bureaus, groups) of preparation and production of statistical materials on sectors of the national economy

9. Chief of management and organization of republic (city) computer-information centers and stations and machine calculating stations

10. Division of management and organization of rayon (city) computer centers (stations) in the Central Statistical Administration system

Division (bureau, group) of organization of machine calculating station operation and mechanization of computer operations in the national economy

9223
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CREATION OF GROUP COMPUTER CENTERS DETAILED

Moscow KHOZYAYSTVO I PRAVO in Russian No 2, 1978 pp 58-61

[Article, by Yu. Naused, director of the Juridical Division of the State Committee for Science and Technology of the Council of Ministers of the USSR; and A. Skachkov, senior scientific associate at the All-Union Scientific Research Institute on Problems of Organization and Management and candidate in the technical sciences "On the Economic Reconstruction of Group Computer Centers"]

[Text] In accordance with the "Basic Directions in the Development of the National Economy of the USSR for 1976-1980", our country has been extensively developing its work in creating collective-use computer centers. They are designed to provide information service to medium-size and small-scale establishments, organizations and institutions independent of the department to which the latter belong. Opening the computer centers themselves to the aforementioned is economically unjustifiable. Simultaneously with the creation of intersector centers in industrial sectors, group computer centers will operate for the introduction and operation of automated production and technological process control systems for a group of establishments and organizations in one ministry. Economic managers well understand what tremendous economic advantages the well-adjusted collective use of computer technology will bring them.

Group computer centers in industrial sectors appear either in the make-up of organizations, establishments or sector production associations, or as cost accounting centers on an independent balance. Here, existing legislation does not limit a ministry in its selection of organizational forms for the operation of the group computer center. Specifically, page 20 of the General Statute on Ministries of the USSR gives them the right to create juridically independent group computer centers, "within the limits of the plan on labor (budget allocations)." Nevertheless, despite the advantages that legal independence could give to these centers, the majority of group computer centers in industrial sectors today operate as establishments (associations) or organizations, doing various types of computer-information operations for numerous outside customers. And it is

impossible to explain such a situation only by some "incubation period" in their development. Until recently these types of independent group computer centers practically did not exist and did not have the economic levers which would have guaranteed their motivation in searching out unused production resources, increasing labor productivity, and expanding their sphere of information service. Questions concerning the stimulation of these centers, and particularly the given workers, were poorly coordinated with the results of their operating activity. The group computer center is something else again. These are among the developed, in an economic sense, establishments and organizations. Here they have had, and continue to have, additional advantages in the area of bonus payments, capital construction, technical means, and selection of personnel. At the same time, in questions of strategy for development and long-range planning, these centers are strongly dependent on the establishments and organizations to which they belong.

A significant change in the legal position of group computer centers was brought about by Decree No. 783 of 26 August 1977 passed by the Council of Ministers of the USSR, extending to the independent group computer centers that possess the rights of a juridical person the action of the Statute on Socialist State Establishment Production, and giving to ministries the right to transfer these centers to a new system of planning and economic incentive. With this itself the juridical base was created for radical improvement of the legal position of independent group computer centers and for the growth of interest on the part of ministry directors in organizing specifically such centers. On the basis of the decree work is being carried out on defining the features of applying the Statute on the Establishment to computer centers on an independent balance and on creating the mechanisms for the financial and economic operation of these centers in new economic conditions. It is advisable to consolidate the indicated features into the General Statute on Computer Centers and, proceeding from this, to develop standard statutes on group computer centers, collective-use computer centers and other types of centers.[1] Questions concerning the financial and economic operation of computer center, in accordance with the decree, will be treated in the Methodological Directives on transferring computer centers to a new system of planning and economic incentive.

In industrial sectors now group computer centers are being transferred to a new organizational and technical base. They are being outfitted with a complex of computing means, subscriber equipment, and apparatus for data transmission. The centers are creating data files that contain the necessary standardized reference, planning, and other forms of general and specialized information, solving questions in programming systems and special problems, and uniting the automated control systems of sector establishments and organizations into a single integrated control system.

[1]Tolstosheyev, V. V., "Pravovoye polozheniye vychislitel' nykh tsentrov" ("The Legal Position of Computer Centers"), SOVETSKOYE GOSUDARSTVO I PRAVO, 1975, No 7.

Group computer center functions are not limited to computation operations along; they are connected above all with retrievals and with implementing effective solutions in the area of the technical, information, and program base of automated control systems. Thus, extending the action of the Statute on the Establishment to independent computer centers is, on the whole, opportune. However, in transferring them to a new system of planning and economic incentive there should be no routing decisions.

The transfer of computer centers to a new system of management is a complicated procedure. To do it, it is necessary to have a developed system of planning which is based on common evaluations (indicators) of the operation of the computer centers, and common, standardized labor and material expenditures and prices for various types of work. Besides this, such a process requires the constant, further improvement and unification of methods for planning, organizing, and standardizing labor, typifying design decisions connected with the creation and operation of computer centers, and greatly organizing their activity on the principals of full cost accounting. In relation to this, we must admit that the transfer to a new economic system in itself can hardly be expected immediately to give all group computer centers the desired results. Actually, on the scale of the whole country, the establishment of stable prices for types of services, under the existing variety of levels of production costs for computer information operations and the levels of computer use at different group computer centers, can result in the appearance in our national economy of a great number of out-dated centers not prepared for operation in new economic conditions. The new financial and economic mechanism would exert a long negative influence on such group computer centers. On the other hand, fixing various prices to similar services in different centers would lead to a wage levelling factor, which is contradictory to the very idea of the economic reform. Proceeding from this, it is advisable to carry out the further experimental development of economic and organizational methods for increasing the efficient use of computer technology in sectors on the basis of the most developed centers (group or collective-use computer centers), having given them the necessary economic rights in the area of planning and economic operating incentive and having provided them with the required material and technical resources. As far as group computer centers are concerned, to which the action of the Statute on the Establishment has been extended, but which have not been transferred to a new system of planning and economic incentive due to their insufficient level of economic development, they are being given the right to form a fund for improving the cultural and personal services of personnel and improving production. It is being created in the conditions and sequence foreseen by Decree No. 563 of the Council of Ministers of the USSR of May 22, 1963, for machine calculating stations. Ten years of experience in work under similar conditions of cost accounting computer centers has already been accumulated by the Central Statistical Administration of the USSR. The indicated fund is formed through deductions on the scale of one per cent from the planning and 15 per cent from the above-plan profit, the total

sum of deductions not surpassing five per cent of the annual wage fund of the computer center personnel recalculated on the volume of actually completed work. The application to certain group computer centers of such limited measures for stimulating production should be viewed as a temporary phenomenon. They are necessary for the period of assimilating the new economic and organizational methods for operation and training to the transfer to the new system of planning and economic incentive.

Questions of the standardization and legal means of group computer centers related to the establishment of the financial and economic mechanism under the new operating conditions of the centers demand an urgent solution. Among them, and above all, we should distinguish questions of developing and planning the basic operating indicators of the group computer centers, the formation and use of economic stimulation resources, profit distribution, credit and estimates, and also bonus payment to the personnel. It is advisable, too, to establish an order for the transition of group computer centers, to which have been extended the action of the Statute on the Establishment, to the new system of planning and economic incentive. There is a sufficient legal base for solving all these questions in economic law. Aside from the previously published standardized acts of the USSR Council of Ministers, the USSR Ministry of Finance, the USSR Gosplan, the USSR Gosbank, and other departments dealing with questions of work planning, profit distribution, accounting with a budget, and industrial establishment credit, the basis for regulating the economic activity of group computer centers can be served by the recently published "Basic Statutes" on the formation and expenditure of the material incentive fund and the fund of social and cultural measures and housing construction for 1976-1980 in manufacturing associations (combines), at establishments and industrial organizations transferred to the new system of planning and economic incentive[1], "Basic Statutes" on bonus payment to personnel at production associations (combines) and industrial establishments for the fundamental results of economic activity[2], and other official materials. In creating the financial and economic mechanism of group computer centers that have not changed to the new economic system, the regulation for the economic activity of the computer centers of the Central Statistical Administration of the USSR can be taken as the basis under the conditions of the centers' using the fund to improve the workers' cultural and personal conditions and improving production.

The Decree of August 26, 1977, of the USSR Council of Ministers resulted in a long discussion of the legal forms of development for juridically independent computer centers. It confirmed the point of view of the

1 EKONOMICHESKAYA GAZETA No 50, December 1976

2 EKONOMICHESKAYA GAZETA No 45, November 1977

majority of specialists[1] that computer centers are relatively independent, productiontype formations which are distinct from the management apparatus as a result of the "information explosion" in management and which are connected above all with training on computers, and not with the computer making of management decisions. However, this progressive idea will not obtain the desired practical conclusion if the features of computer centers as production establishments do not find sufficiently precise, juridical expression in normative formal documents.

The features of group computer centers which distinguish them from among industrial establishments proceed from the informational character of their production activity. They should be treated in laws that provide for the accomplishment of the basic functions of group computer centers: training and tie-in to the objects of programming automation, solving and grouping the problems of automated control systems at various sector establishments and organizations, organizing data files, and others. Accordingly, these are laws in the area of planning, capital construction and repair, improving production techniques and technology, supply and marketing, finance, labor and wages, that have been fixed by the Statute on the Establishment and by changes and additions caused by the specific features of group computer centers. These changes and additions could be fixed in a standard statute on group computer centers that are on an independent balance. For example, among the supplements in a standard statute there could be laws on the observation of establishments and organizations--the objects of automation, on the timely receipt from establishments and organizations, group computer center subscribers, data on changes in normative-reference information, a law for making an agreement for technical service of computer technology, and many others.

However, the specific nature of the group computer center should be treated not only in the economic laws. Important topics, on whose solution depend the results of the production and economic operation of the centers and prospects for the development of automation in industrial sectors, are the selection of plan and accounting indicators for group computer center operation and the tie-in of plan indicators with the incentive system. Along with the usual confirmed indicators of labor, finance, the introduction of new technology, and others that operate in industry, it is necessary to establish, in legal order, fund-forming and accounting indicators which would reflect the level of accomplishment by the group centers of plan assignments in introducing and grouping problems of automated production and technological process control systems at establishments and organizations serviced by the group computer centers, as well as tasks in creating group information and programming funds. The stimulating role in accepting and fulfilling stepped-up plans for these types of operations should be played by prices and norms of forming the material incentive fund.

[1]See, for example, V. M. Glushkov, "Upravleniye EVM. Pravo" ("Management. Computers. The Law"), KHOZYAYSTVO I PRAVO, 1977, No 1.

The legal measures examined above, and other similar ones, for the economic reconstruction of independent collective-use computer centers will, in our opinion, increase the efficiency of using computer technology in industry.

9223
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CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

TIME-SHARING COMPUTER SYSTEM VITAL TO ESTONIAN SCIENTISTS

Tallin SOVETSKAYA ESTONIYA in Russian 20 Jun 78 p 2

[Article by A. Vyrk, deputy director for scientific studies, Institute of Cybernetics, Estonian SSR Academy of Sciences, and candidate of technical sciences: "Estonia Will Have Its El'brus"]

[Text] A time-sharing computer is taking shape, by decision of the Estonian SSR Academy of Sciences, to raise the effectiveness of scientific research to speed the adoption of research findings in the national economy. Construction of this system was assigned to the Institute of Cybernetics, Estonian SSR Academy of Sciences--the republic's leading collective in systems programming and in the development and application of new computer equipment.

Today we familiarize our readers with questions about developing and adopting a high-capacity computer system based on the fourth-generation El'brus-1 computer. This effort will consist of participation in meeting the challenge posed by the 25th Party Congress--to advance scientific studies aimed at upgrading and effectively applying computers in the national economy.

In the first place, just what is a time-sharing computer system (TSCS)?

Generally, this kind of computer system is based on a computer specifically designed for time-sharing use. It includes, besides the computer, a data transmission system and numerous remote units (terminals) that the user needs for operating the computer. In principle, these are the same input/output units used daily in all computer centers, but in this case there are many more of them (from 10 to 200 sets) and they are divided among the users--placed in the hands of the programmer, mathematician, designer and economist right at their work stations. All the resources of the computer--processor time, memory and programs--can be tapped via the terminals and the telephone lines.

Universality is the primary feature and one of the main advantages of the TSCS: all TSCS subscribers can use several programming languages, compile, debug and execute their programs in parallel and independently of each other. Thanks to this feature and the possibility of communicating with the computer at any time, the programmers' labor productivity multiplies by tenfold.

The computer in this system operates in the so-called time-sharing mode, that is, "it shares attention" with one user each time only for several milliseconds, but on the other hand, does this very often. The effect turns out to be the same as if all the time the computer was working for you! Naturally, if there are several dozens of users at the same time, the computer itself must be fast enough, otherwise the response time will be markedly or even extremely long. Regrettably, when the number of terminals functioning at the same time is increased, the service time for each client drops off. The appropriate ratio between the computer capacity of the host computer and the number of terminals is the duty of the TSCS designer to select.

Generally, today computers in our computer centers operate in the batch mode, that is, one after the other as large a number of tasks as possible is handled. Even so, there are sometimes cases when--owing to low productivity in the programming--the engineers and mathematicians are unable to prepare the tasks well enough even for normal computer workloads. But it would be incorrect here to draw the conclusion that the computer is generally not needed! Granted, the programmer's efficiency is very low, therefore even the actual programming develops much more slowly than does the computer. But the conclusion is that even here we have time-sharing computer systems with the corresponding programming units. Their specific aim, as we already know, is servicing each client the most rapidly as possible and furnishing him with the maximum conveniences in communicating with the computer.

What good does the STCS do for the Estonian SSR Academy of Sciences? The volume of computing work in our academy's institutes when meeting planning and economic contract obligations grows year after year; therefore, with each passing year our institutes increasingly need to have their own computers or to purchase computer time. We know that acquiring one powerful computer is more economically than buying several moderate-capacity models, in other words, computing needs centralization. As viewed by users, to make computers more effective it is best that each user have his own computer; it can be used operationally at his discretion, as slide rules or handheld calculators are used nowadays. That is, the result turns out to be that the centralized execution of computing operations and the decentralized distribution of services are provided actually by the time-sharing systems, the TSCS. Because it is universal, it permits execution of its function by each academy subdivision.

The institutes of the Estonian SSR Academy of Sciences have a long series of scientific problems whose solution is contingent on the use of high-capacity computers. Many of the problems today are finding solution with simplifications or in general are not brought to computer program status, since solving them with medium-size computers is not possible or not practicable.

Medium-size computers have inadequate, for example, operating speeds and memories for executing complex multidimensional problems in astronomy, physics, mechanics or machine design and for building information retrieval systems. These computers lack needed input/output devices (for example, units for graphic display of information for engineer-computer communication in terminals he is used to). And naturally, a person will not use an automatic information retrieval system if he can get the answer faster manually. It is quite another thing if the right kind of screen console is at arm's reach and the answer from the computer shows up on it in a couple of seconds. By the way, there are many tasks where the necessary accuracy without computers in general cannot be obtained.

A large computer is capable of handling fundamentally new scientific tasks; besides that, it makes it easier to write and debug any new programs, since the programmer who works with a large computer does not need to make allowance for the numerous constraints so common when working with other computers.

One more thing: a plus feature of the TSCS is the possibility of operating with applied programs written by one institute in all the other institutes. (For example, the automatic control system our institute wrote can be applied in all institutes.) Now, of course, each establishment deals with its own data bases; access to "other" data bases must not be possible. This inviolability of data is incorporated as a binding condition in building the operational system of the TSCS.

Some problems in building the TSCS of the Estonian SSR Academy of Sciences. We must not forget, particularly in designing time-sharing computer systems, that computers work for people, not the other way around. So the host computer in the system must be selected so that scientists need not stand "in line" at the computer.

World practice showed the following: it is absolutely not necessary for all terminals to be on all the time for the effective performance of clients as a whole, the peak hours included. The total number of terminals can be 2.5 times larger than the number occupied at the same time. What this means for the Estonian SSR is that about 100 input/output devices have to be installed: mainly, alphanumeric screen consoles with keyboards (displays) and printers in all institutes (including the Institute of Physics in Tartu and the Institute of Astrophysics and Atmospheric Physics in Tyravere. Additionally, even greater-capacity terminals need to be installed in a number of institutes: with input/output devices based on punched cards, punched tapes and magnetic tapes and alphanumeric printers. The most specialized and expensive units, for example, screen consoles on which the computer writes formulas or plots graphs, are best operated first in a centralized way and placed in the central part of the computer system.

Now this question naturally comes up: if there a possibility of building this STCS with many dozens of terminals in institutes and what does this require?

To the first question a short answer can be given: yes, there is a possibility. The first prototypes of the El'brus-1 multiprocessor computer complex (MCC) were built in our country late last year. One prototype will be received even by the Estonian SSR Academy of Sciences late in 1980. What does one visualize when the El'brus-1 MCC is mentioned? Its central processor executes 1.5 million operations a second, but more importantly, the El'brus-1 MCC can have as many as ten central processors; in addition, there are available specialized processors (input/output and data acquisition/transmission) for servicing clients, thereby relieving central processors of all "ancillary" operations. By the way, one of the inventors of the El'brus-1 MCC, corresponding member of the USSR Academy of Sciences V. Burtsev, wrote interestingly about this in PRAVDA; he emphasized the new design solutions and the possible applications of large computers.

To the second question--what does building this system require of us, a short answer cannot be given. First, there must be means for acquisition of the El'brus-1 MCC as such and its terminals. USSR Gosplan promised to be responsible for these expenditures; on its own part, it is concerned about the rapid adoption of the first domestic multiprocessor, fourth-generation, computer complex. (This confidence grows out of the scientific results and the experience of the Institute of Cybernetics, Estonian SSR Academy of Sciences, which is well-known to the El'brus-1 developers.)

Many unresolved questions are associated with the future transmission of data between the central part of the computer and the institutes. Telephone channels specifically allocated are needed; this is not so easy to bring about, given the overloading of the Tallin telephone system. On the other hand, data transmission between, for example, Tallin and Tartu, for which channels are available, at current tariff rates comes to 15 kopecks a minute, the same as for an ordinary city-to-city call. (Over a year this comes to 78,000 rubles!) Happily, the Estonian SSR Ministry of Communications is dealing with the academy STCS in an understanding and supporting manner; it has already moved toward the first practical steps in setting up a data transmission network.

Well, then, El'brus-1 provides for using computer facilities at a fundamentally new level and enables users right at their work stations to continually and directly communicate with the computer. But these potentialities are embodied only when failure-free operation of the computer system is provided without interruption 24 hours a day, seven days a week. This performance can be guaranteed only by exact compliance with all technical requirements of computer installation and operation. This includes cooling of computer supports, air conditioning in the computer rooms, conditions of storage of magnetic and paper data media, conditions of preventive maintenance of mechanical assemblies of the system and much more. Therefore, it is so important now to give special attention to designing and constructing rooms for the central part of the system. The architects and engineers of Estonproyekt designing the computer center for the Institute of Cybernetics in Mustamyae and keeping in mind the El'brus-1 requirements have very successfully allowed

for the possibility of constructing the computer center with a separate autonomous building. This makes possible the preparation of excellent rooms for installing the first domestic multiprocessor computer complex as early as late in 1980. It remains to hope that the Estonian Ministry of Construction will manage with the vital work on schedule.

Now, of course, besides the organizational, there is also a good number of scientific and technical problems in building large shared-time computer systems. These problems were the subject of an all-union conference recently held in Riga, with the participation of the USSR Academy of Sciences and the academies of sciences of all union republics. At the conference the emphasis was on the necessity of all feasible coordination of scientific research in this field.

We have not discussed here what the El'brus-1 MCC will mean for the entire republic. One thing is clear: we intend to "milk" from the complex everything we can. Already now, for example, the computer center of Estonian Radio is under development at the TSCS of the Estonian SSR Academy of Sciences.

At this point let us briefly take up what part is played by systems programmers of the Institute of Cybernetics, Estonian SSR Academy of Sciences. They face not only the mastery and adoption of the system, but also its upgrading. Specifically, they will develop a programming system for the automatic writing of program packages.

In conclusion, let us present some remarks from the regular congress of the International Federation of Information Processing, held in Toronto last year. These statements vividly characterize the "hot points" of today and tomorrow in building computer systems and networks in the whole world.

"Computer networks with package transmission of information have grown most vigorously over the past ten years."

"The concentration of computer capacities will yield a payoff (from the greater operating economy of consolidated memories and also a reduction of operating costs). Dividing the general-purpose central computer center into smaller centers, still general-purpose in scope, is uneconomic."

"At the present time expenditures in paying for the communication channels in the information systems between the host computer and users come to a fourth of all operating costs."

"The costs of transmitting data over a communication channel are being reduced an average of 10 percent a year."

"The volume of computer operations on customer order is rising by 19 percent a year in Canada, by 24 percent a year in France, 27 percent in the FRG and by 40 percent a year in Japan."

"It is assumed that in the future software will account for about 90 percent of total computer system costs."

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CSO: 1870

MAN-MACHINE DIALOG WITH YES-1030, YES-1033 COMPUTERS IN ESTONIA

Tallin SOVETSKAYA ESTONIYA in Russian 20 Jun 78 p 2

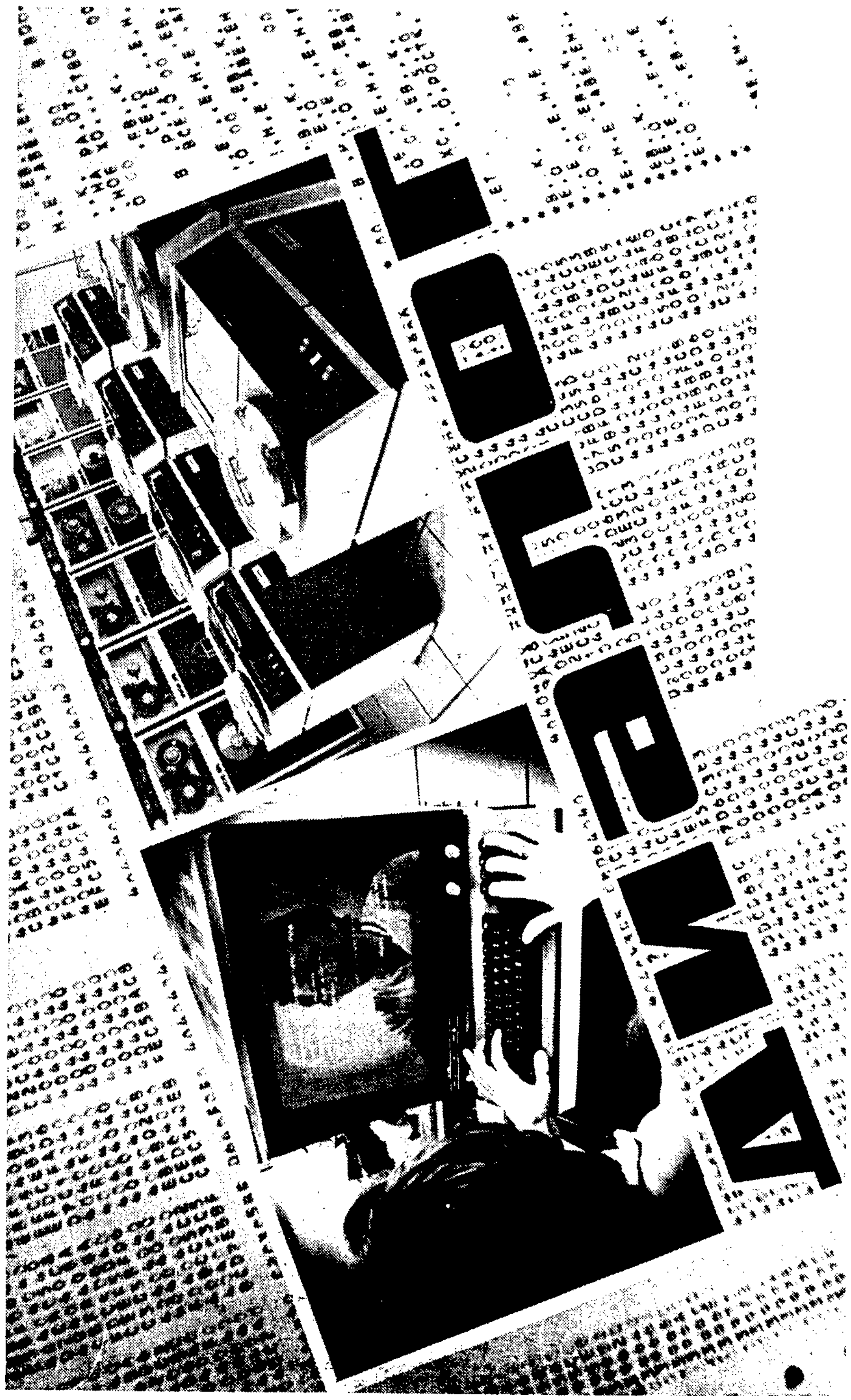
[Article by A. Sirel': "Dialog"]

[Text] A dialog between a person and a computer will run like this. The electronic "brain" and the customer can communicate over a distance of many kilometers just as if they were in the same room together. Question, answer, and in rapid-fire.

Incidentally, these photographs below show computers still in the third generation, operating now in the Computer Center of Estonian SSR Gosplan. Here the computers are assigned the accounts used in formulating the state plans. In operating speed, these computers are thus far the most powerful in the republic. One computer, YeS 1030, executes 70,000 operations a second; a "newcomer" to the center, the YeS 1033 computer, "counts" three times faster still.

The YeS is a unified series of computers, jointly manufactured by CEMA countries. The most powerful computer blocks are built in Kazan'. Their "memories" (magnetic tapes) are made in the USSR, the GDR and Bulgaria. The printers are manufactured in Poland and so on. The software for these computers is designed so that they can execute at the same time a great many tasks under numerous programs. Here, in the Gosplan Computer Center, they run through 100 to 200 programs a day. Later on, both computers will be combined in a computer complex, for even more efficient use of their capabilities.

Until the fourth-generation of computers comes on the scene, their predecessors will serve honorably in the national economy.



[No caption given in text]

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PHYSICS

STATE OF THE ART, OUTLOOK AND PROBLEMS OF FUTURE LASER-DRIVEN FUSION POWER

Moscow PRIRODA in Russian No 6(754), Jun 78 pp 26-37

[Article by N. G. Basov]

[Text] Nikolay Gennadiyevich Basov, academician, member of the Presidium of the Soviet Academy of Sciences, director of the Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, chief of the Quantum Radiophysics Laboratory of the same institute. One of the developers of the maser and various types of lasers; is working on the use of these devices in various fields of science and technology. Holder of the Lenin and Nobel prizes, Hero of Socialist Labor, foreign member of the academies of sciences of a number of nations. Chairman of the Board of the All-Union Znaniye Society. Editor-in-Chief of *Priroda*. Has had a number of articles published in *Priroda*.

The use of lasers may play a considerable part in solving the energy problem -- one of the most acute problems facing future generations. Physics research in this area was started about 15 years ago, and now active multifaceted work is in progress throughout the world directed at implementing the idea of laser-driven fusion conceived in our nation.

The principle of energy production in laser-driven fusion is as follows. A thermonuclear target in the shape of a sphere containing thermonuclear fuel (a mixture of deuterium and tritium) is exposed to laser beams on all sides. As it is absorbed, the radiation vaporizes and heats the material, resulting in dispersal of the outer part of the target -- the "corona" -- counter to the laser beams. In keeping with the law of conservation of momentum, the inner part of the target moves toward the center with compression and heating to such an extent that thermonuclear reactions develop in the thermonuclear fuel. As a result of these reactions, a micro-explosion takes place, providing energy that can be converted to electricity.

Notice that in an arrangement of this kind we can also use relativistic electron and ion beams instead of laser emission. However, an analysis of the physical characteristics of corpuscular and light beams, in our opinion favors the choice of laser radiation. First of all, laser emission is absorbed by an extremely thin (10^{-3}-10^{-4} cm) layer of the target; as a result, high pressure is created "from the outside," and excellent implosion of the deuterium and tritium is achieved. Under these conditions, intense thermonuclear combustion is possible. Corpuscular beams (especially relativistic electrons) penetrate to a much greater depth; this leads to preheating of the fuel, reducing the implosion and the thermonuclear yield. Besides, the coherence of laser radiation ensures high specific power of the energy release process (10^{18} W/cm^3 as against 10^{14} W/cm^3 for corpuscular beams), and also enables tailoring the pulse shape in time and transporting the laser emission over considerable distances. There is every reason to assume that these properties of lasers are retained with transition to large energy scales -- an energy of $\sim 10^6$ J is attainable on the basis of current technology.

At the same time, there may be unfavorable conditions in the case of laser radiation as well. For instance secondary emission -- x-rays or hard electrons -- may arise in the radiation absorption zone. This also leads to preheating of the target, and in the final analysis to a reduction of the thermonuclear yield.

Let us examine the conditions under which a closed energy cycle can be realized in laser-driven fusion with production of useful energy. We will analyze the following process: a laser emits an isolated light pulse; this pulse initiates a thermonuclear reaction in the reactor; the energy of the thermonuclear reaction is converted to electric energy; part of this energy is returned to the installation for laser supply, and the other part can be used in a conventional manner. Of course, consideration must be taken of the losses of energy liberated in the form of heat. Then let the laser pulse energy be E_L. If η is the laser efficiency, then electric energy E_L/η must be expended to produce such a pulse. In the reactor, the energy of the laser pulse will be amplified by a factor of K; thus an energy of KE_L goes to the electric generator. Only a part of this energy is converted to electricity: αKE_L (α is the generator efficiency). The other part $(1-\alpha)KE_L$ is converted to heat. Thus the amount of useful electric energy is

$$E_L(\alpha K - 1/\eta),$$

and the total amount of thermal energy is

$$E_L[(1-\alpha)K + 1/\eta - 1].$$

We can take the ratio of these quantities as the characteristic efficiency of the cycle:

$$\beta = \frac{\alpha K - 1/\eta}{(1 - \quad)K + 1/\quad - 1}.$$

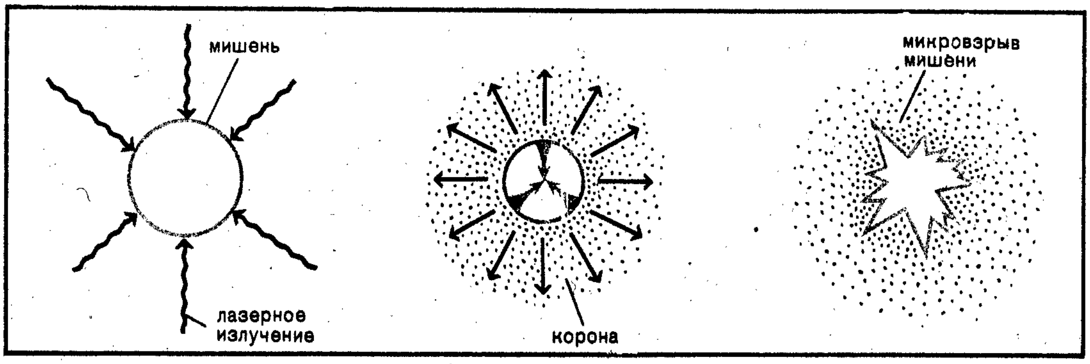


Diagram of formation of a thermonuclear micro-explosion:

мишень = target	корона = corona
лазерное излучение = laser emission	микровзрыв мишени = micro-explosion of target

Comparison of Laser and Corpuscular Beams as Sources of Initiation of a Thermonuclear Reaction

Characteristics	Lasers	Electrons	Ions
Total energy, kJ	1	100	10
Pulse duration, ns	0.1-100	25-100	25-100
Size of focusing spot, μm	up to 50	10^3	10^4
Power flux, W/cm^2	up to 10^{17}	10^{13}	10^{10}
Specific power of energy release process, W/cm^2	10^{18}	10^{14}	10^{14}
Pulse tailoring capability	yes	?	?
Efficiency, %	0.2-5	30	?

If the values of β and α are given, one can find the dependence of laser efficiency on the energy gain K in the reactor for a cycle that is justified from the energy standpoint. For instance when $\beta = 3/7$, $\alpha = 0.5$, $\eta = 3$-5%, we must have an energy gain in the reactor $K = 170$-100. If $K = 10^3$-$3 \cdot 10^3$, it should be possible in principle to use lasers with $\eta = 0.3\%$. Thus these energy considerations show a strict relation between the characteristics of the laser system used in the electric power plant and the energy gain of the thermonuclear targets.

It should be noted that the above considerations on closure of the energy cycle are suitable for any methods of initiating thermonuclear reactions. For instance if an electron beam is used instead of a laser, it can be assumed that 20% of the electric energy is converted to kinetic energy of electrons. Then the energy gain of the targets must be at least 50.

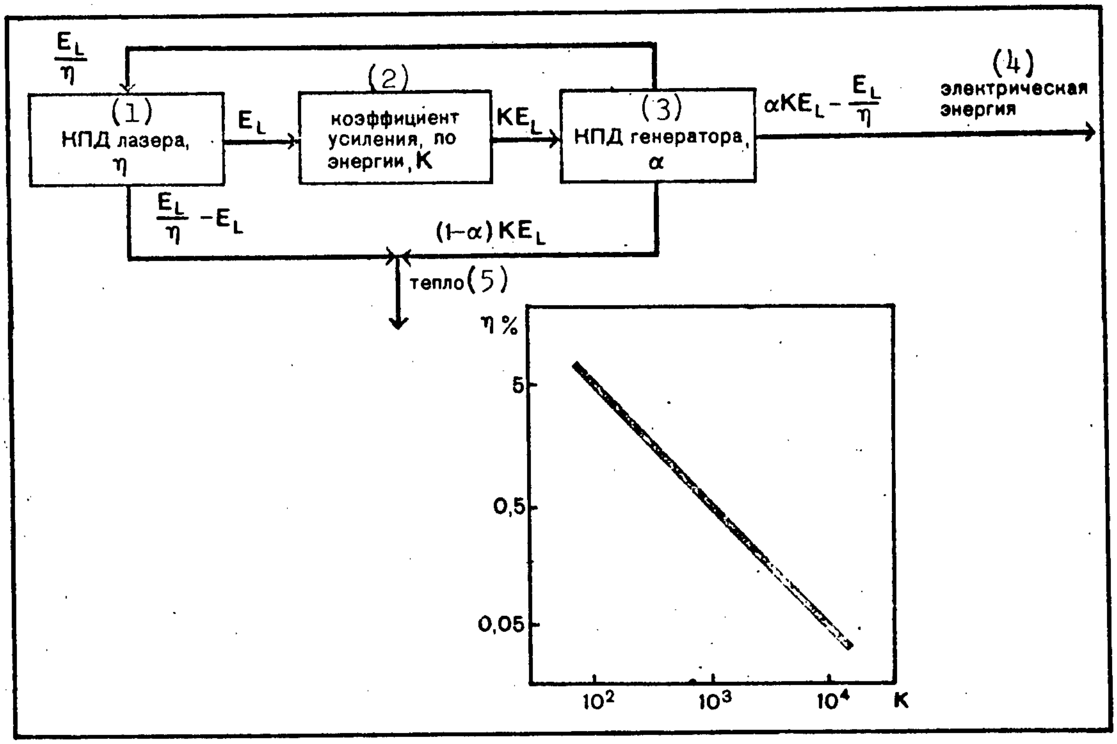


Diagram of the energy cycle in a laser-driven fusion power plant and graph of laser efficiency η as a function of the energy gain K in the fusion reactor

KEY: 1--Laser efficiency η
2--Energy gain K
3--Generator efficiency α
4--Electric energy
5--Heat

And so we come to the question of whether physics can give us any grounds to hope that these severe conditions can be met.

LASERS

Obviously, the lasers that will be used in industrial power plants must differ from those used in experimental research.

In particular, we showed above that laser efficiency must be strictly dependent on the energy gain of the targets. Understandably, this relationship is not significant on the research stage. Nor is the limiting duration of operation of laser facilities an important factor on this stage, whereas in the electric power plant this duration must be at least 10^8 pulses, i. e. 10^5 times the duration of operation of modern laser facilities. Finally, a laser installation must be created that will operate at a recurrence rate of 1-10 Hz while meeting all other requirements; experimental laser systems can emit only isolated pulses.

Lasers of several types are being developed, produced and used for research purposes in laboratories around the world. At the present time, neodymium

glass and CO_2 gas lasers have the most satisfactory parameters. The main thrust of work in our laboratory involves neodymium lasers. At the same time, we have developed and are using a powerful iodide laser, and are looking into the possibilities of the chemical laser and high-pressure gas lasers.

At the present time, construction is being completed on the powerful Del'fin laser facility with pulse energy of 10^4 J. This installation is a laser with a series-parallel system of optical amplifiers. Two types of lasers are used as the "master oscillator": Q-switched and with passive mode locking. This gives a pulse duration range of 10^{-8}-10^{-10} s. A system of preliminary amplification stages provides the following laser emission parameters at the output: pulse energy 30-50 J, divergence 10^{-4} radian, contrast at least 10^7. This beam is split four ways, and each of these four beams is coupled into the power stages of the optical amplifiers, where sequential beam splitting is combined with additional amplification. There is a total of 216 beams at the output. The optical arrangement of output stages, splitting and branching of the beams provides for automatic compensation of the optical path difference in the individual amplification channels.

All amplification stages are based on the GOS-1001 amplifier with optical element that is a neodymium glass rod 45 mm in diameter with pumped section 570 mm long. In structure, the amplification stages are two types of cells containing 28 or 18 elements.

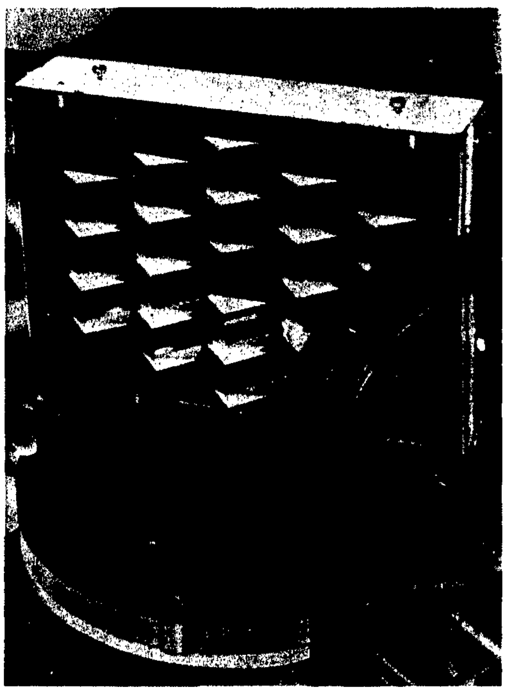
Laser power concentrators must be used to focus the 216 laser beams on the spherical thermonuclear target. These are multiple-prism mirrors, with 18 parallel beams 45 mm in diameter incident on each of them. The beam formed by a concentrator has a diameter of about 280 mm and energy of 0.9 kJ. These composite beams are focused on the target by 12 objective lenses through ports in a vacuum chamber. Focusing symmetry is cubic, four beams being introduced along each pair of mutually opposite axes with apertures that do not overlap (to prevent self-excitation of the laser). All elements of the laser facility, vacuum chamber and diagnostic equipment are located in an optical room with area of 685 m^2. The laser is installed on a vibration-resistant base. A bank of storage capacitors and a system of devices for charging them are installed in a basement enclosure directly beneath the facility. The energy accumulated in the storage bank is about 10 MJ.

Calculations show that when the planned parameters of the facility have been attained, effective heating of thermonuclear targets will be possible with a physics demonstration experiment in which the energy of the thermonuclear reactions will be equal to the energy of the laser emission expended on heating the thermonuclear plasma. Thus we believe that neodymium lasers can meet the requirements of the physical stage of research, including a demonstration experiment. An extensive research program using neodymium lasers is also in progress in the United States at Livermore Laboratories and in a number of other physics laboratories around the world.

Undoubtedly, CO_2 lasers will also be useful for the research and demonstration phase. Great strides have been made in this direction in recent years. In

particular, a laser with energy of 10 kJ (5% efficiency) has been developed for research on laser-driven fusion at the Los Alamos Laboratories in the United States, and plans have been developed for a laser with energy of 100 kJ.

Which of the lasers will be suitable for future power plants? There is no single answer to this question. However, neither is there any physical prohibition to reaching the necessary parameters in laser facilities. Possible directions of work may involve the development of high-efficiency CO_2 or chemical lasers. In our opinion, consideration should be taken of the neodymium laser as well since an efficiency of a few tenths of a percent or 1% may be applicable to hybrid electric power plants, and such an efficiency is attainable if provisions can be made for the required matching of the duration and spectrum of pumping to the optical characteristics of neodymium glass.



The energy concentrator is a multiple-prism mirror

THERMONUCLEAR TARGETS

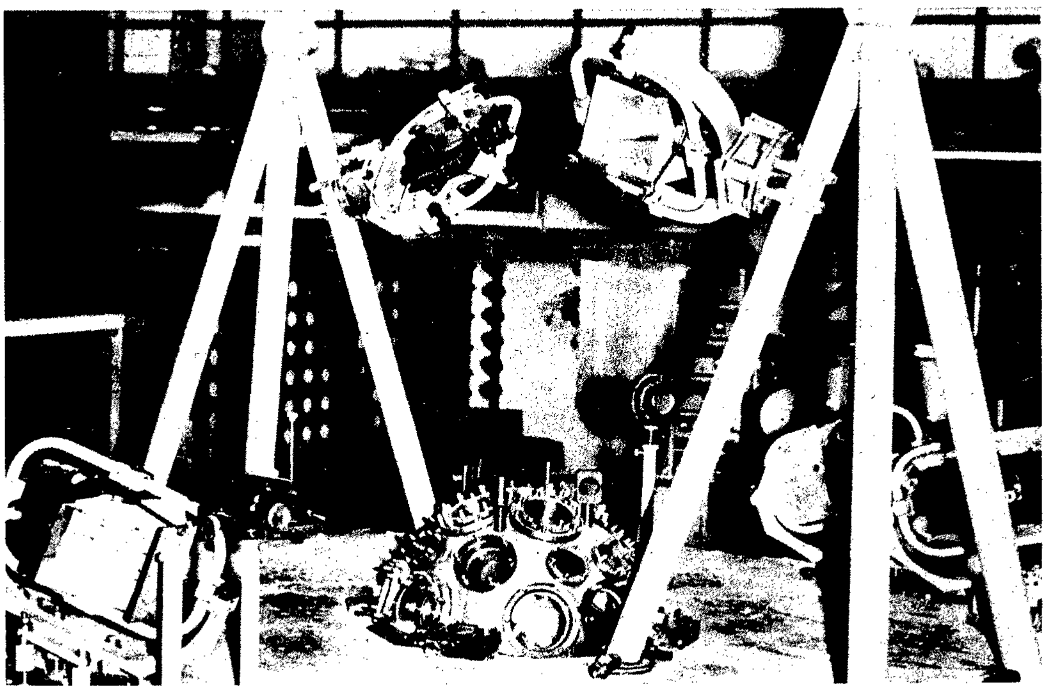
It is relevant to begin discussion of the problem of thermonuclear targets with experimental results that reveal two trends in the development of laser-driven fusion. One direction is based on the use of short laser pulses and high irradiation fluxes (10^{16} W/cm^2 or more). This area is being developed in the Livermore Laboratories and certain others. With this approach, stable implosion is fairly readily achieved; however, an appreciable fraction of the energy is lost in reflection of the radiation from the target. Besides, in this instance an unfavorzble state arises in which hard radiation is developed that heats the target, reducing the thermonuclear yield. Nonetheless the neutron yield per joule in such experiments has been $7 \cdot 10^6$, and the optical thickness of the fuel (i. e. the product of its density multiplied by the radius) has reached $2 \cdot 10^{-4}$ g/cm^2. The efficiency of quasi-steady state nuclear facilities with magnetic plasma containment is usually characterized by the parameter $n\tau$, where n is average density and τ is the time of containment of the thermonuclear fuel. The quantity $2 \cdot 10^{-4}$ g/cm^2 corresponds to a parameter $n\tau = 10^{12}$.

From our standpoint it is more reasonable to use long laser pulses and moderate radiation fluxes (10^{13}-10^{15} W/cm^2). In this case the disadvantages noted above are eliminated, but the problem of stability becomes more intense.

In experiments conducted on the "Kal'mar" facility at the Physics Institute of the Academy of Sciences a spherical thin-walled glass target with radius

$R = 30-70$ μm with a wall thickness of $\Delta R = 1-3$ μm filled with deuterium under a pressure of 35 atmospheres. The spherical symmetry of the target was close to ideal.

The laser energy absorbed in the target was about 30 J. A deuterium gas density of about 8 g/cm^3 was attained (volumetric compression by a factor of at least 10^3). The neutron yield in the resultant DD reactions was $3 \cdot 10^6$ per pulse (when the target is filled with a deuterium-tritium mixture under these same conditions the neutron yield could be 10^8).



Vacuum chamber for a thermonuclear target (a fragment of the "Del'fin" unit)

Analyzing these data we can state that of all the thermonuclear experiments currently in progress it is in the laser experiments that the greatest neutron yield is achieved with respect to the energy absorbed in the plasma.

In this connection, the energy absorption is about 30% in the experiments discussed. With an increase in target dimensions, energy and duration of exposure, i. e. when moderate laser emission fluxes are used, absorption may amount to 70-90%.

However, let us return to the question of implosion stability.

Experience has shown that implosion is stable for targets with no more than a 3% deviation from spherical shape and a ratio $R/\Delta R = 35$. But there is no

simple answer to the question of whether we can expect stable implosion for targets with a greater ratio $R/\Delta R$ on the basis of this fact. With respect to the ignition problem which is important for thermonuclear combustion of large targets, and hence for predicting the characteristics of an electric power plant, we have no experimental data right now, and our only basis here is mathematical modeling of the processes in targets. We are doing this work, and also computer analysis of experiments in cooperation with the Institute of Applied Mathematics of the Academy of Sciences USSR. Our mathematical-physics model of processes in a laser target is incorporated in a number of one-dimensional and two-dimensional programs. In one of the numerical experiments in the "Luch" program solutions are found for two-temperature hydrodynamic equations with consideration of electron heat conduction, transport of thermonuclear particles, preliminary heating, and actual equations of state, transport and absorption of laser radiation. The program has shown good correspondence between calculations and physical experiments, which gives us grounds to hope for justification of computer predictions.

Calculations show that with stable implosion and a laser emission energy of 1 MJ we can get a thermonuclear yield of 1000 MJ. Whether such an experiment can be carried out depends on the precision with which targets are made and the exact knowledge of the boundary between stable and unstable implosion. This also depends on the process of initiation and propagation of thermonuclear reactions from the initiation region throughout the fuel. But the knowledge that a high thermonuclear yield is physically possible gives us "capital" that can be invested in cheap targets, or implosion stability, or in relaxed requirements for the laser system, or in more economic design of the laser-driven fusion reactor.

LASER-DRIVEN FUSION REACTOR

Research associated with developing a laser-driven fusion reactor is undoubtedly a most important problem alongside the development of lasers and thermonuclear targets. At present there are not sufficient data for the engineering design of these reactors; however, preliminary development of such designs is necessary since it is this development that enables determination of the parameters of lasers and targets that are necessary for creating a laser-driven electric power plant. We have worked out such a preliminary design of a laser-driven fusion reactor in cooperation with the Institute of High Temperatures of the Academy of Sciences USSR. Similar projects are in progress in the United States and West Germany as well.

The difficulties that arise in reactor design are associated primarily with the peculiarities of energy released as a result of the thermonuclear reaction. A specific feature of the deuterium-tritium reaction is that the main part of the energy (about 71%) goes to fast neutrons with high penetrating capacity, and only 23% goes to charged particles. Efficient conversion of the energy of products of the thermonuclear micro-explosion (fast neutrons and alpha particles) to one of the forms of energy dictated by the consumption structure (electricity, heat, chemical or the nuclear energy of secondary

fuel) is a complicated scientific and technical problem. Obviously we must base our solution of this problem on technological possibilities of the present or the foreseeable future.

And so the laser-driven fusion reactor must first of all ensure:

optimum conditions for introducing the deuterium-tritium target and laser radiation;

containment of the products of the micro-explosion in an indestructible shell (explosion chamber) during the first stage of conversion of the energy of the thermonuclear micro-explosion;

the capability of repeated micro-explosions in a quasi-steady state with fairly high frequency;

tritium breeding capability.

These jobs dictate the design peculiarities of the reactor. In our design the explosion chamber is a spherical cavity formed by the so-called first wall, which must ensure adequate strength with respect to pulsed mechanical loads with pressure of dozens of kilobars for times of the order of 10 μs. The explosion chamber is also surrounded by a spherical surface, and the space between these two spheres is filled with liquid lithium (this part of the construction is called the blanket). The main function of the blanket is to moderate and absorb fast neutrons, to breed tritium (tritium is formed in the ^{6}Li isotope with neutron absorption) and to act as a coolant. The outside part of the reactor must ensure reliability and safety of operation.

There are several concepts of explosion chamber design. The fact is, that the first wall not only has to satisfy strength conditions, but must also compensate for the material vaporized from the inside of the wall by streams of x-rays and alpha particles. In our opinion, the most interesting of these concepts are explosion chambers with "wet" and "dry" walls.

In the "wet" wall arrangement, damage to the explosion chamber is prevented by a thin film of liquid lithium that coats the inner surface. As it absorbs gamma rays and alpha particles formed in the thermonuclear reaction, this film vaporizes, cooling the "intact" wall of the explosion chamber. As the micro-explosions are repeated, the film is renewed by lithium coming from the blanket. In such an arrangement, the first wall is a multilayered grid with porosity and thickness chosen in such a way as to ensure absorption of gamma rays and alpha particles in the lithium film that covers the complex surface of this grid.

The chamber with "dry" wall is not renewed throughout the entire period of utilization for which it is designed. A substance with high vaporization point such as graphite that is evaporated from the wall by fluxes of alpha particles and gamma rays is redeposited in a short time as a result of intense external cooling. Of course, the shape of the cavity is distorted with time;

however, estimates have shown that the time required for drastic changes in shape may be long enough to make the proposed solution technically feasible.

Our analysis with the Institute of High Temperatures on different concepts in design of laser-driven fusion reactors has convinced us that the "wet" wall arrangement is fundamentally best for the near future. In this connection, the inside diameter of the explosion chamber should be determined with consideration of such factors as:

the neutron flux density on the first wall of the reactor and on the output optical elements of the laser system (it must not reach a level where radiation changes occur in optical and mechanical properties of materials);

the mass of the vaporized substance and the emptying time of the explosion chamber;

the intensity of the shock wave excited in the blanket;

the relative volume occupied by structural materials in the tritium breeding zone.

Parameters of Laser Systems

Name of system	Laboratory	Pulse energy kJ	Pulse duration ns
	Neodymium lasers		
Kal'mar	Lebedev Physics Institute USSR (1970)	0.2	2
Del'fin	Lebedev Physics Institute USSR (1979)	10	1
Shiva	Livermore, United States (1978)	2	0.1
Gekko XII	Osaka University, Japan (1980)	10	0.2
Omega X	Rochester University, United States (1978)	10	0.3
	CO_2 lasers		
8-beam system	Los Alomos, United States (1978)	10	1
HEGLF	Los Alomos, United States (1981)	100	1
		80	0.25
Lekko X	Osaka University, Japan (1980)	10	1

An analysis of calculations has shown that for small diameters of the explosion chamber ($D \approx 1$ m) the impact loads are so great that the volume of the structural materials in the tritium breeding zone increases excessively. This leads to a sharp reduction in the tritium breeding ratio. Besides, in this case the neutron flux density on the first wall reaches high values (of the order of 10^{15} cm^{-2} s^{-1}), which corresponds to a very rapid accumulation of the neutron dose that can reduce the strength of the structure.

A tenfold increase in the inside diameter of the chamber and construction of the first wall as a multilayer grid that allows repeated structural damage enables an increase in the rated duration of reactor operation to the minimum technically feasible level, although the problems of neutron damage to the structure and the optical elements remain quite critical. An explosion chamber of large size also looks preferable from the viewpoint that evacuation time after target explosion and vaporization of the lithium film decreases (with a fixed ratio between the area of the vacuum port and the surface of the chamber). Evacuation of the explosion chamber is handled by free discharge into vacuum.

However, with an increase in the dimensions of the explosion chamber the capital expenditures on reactor construction become more and more burdensome in the overall expense balance sheet, and therefore a chamber of very large dimensions is likewise unacceptable. In the final version, an inside chamber diameter of 10 m was taken with relative area of the vacuum port of 5%.

In the design of which we are speaking, an electron-beam controlled CO_2 laser was taken as the initiating laser; pulse energy is $5 \cdot 10^5$ J, laser efficiency is 5%. The energy gain in a micro-explosion is taken as equal to 100.

LASER-DRIVEN FUSION ELECTRIC PLANTS

A specific feature of thermonuclear power plants with laser initiation is the high expenditures of energy on internal needs. For instance with a laser efficiency of 5%, energy gain in the reactor of 100, and efficiency of the system for converting energy to electricity of 40%, the internal needs of a laser-driven fusion electric plant (LFEP) are equal to the electric power delivered to the consumer. This is approximately ten times the level in modern fossil-fuel electric plants. There is no doubt that such considerable in-house energy consumption is detrimental to the comparative technical-economic indices of the LFEP. Therefore it is relevant for such power plants to bring up the question of utilizing the heat dissipated by the laser system.

Our design provides for a high degree of utilization of laser heat. The idea is to use a fast-flow CO_2 laser (i. e. one in which the gas in the working volume moves at high velocity). The gas heated in the pumping process gives up its heat to the first stage of a heat exchanger and steam generator to heat water (from 543 to 622 K). If the heat exchanger and steam generator is considered as an analog of the boiler unit in the conventional steam turbine electric plant, then we can speak of a kind of laser economizer. The use of laser heat enables an appreciable increase in the efficiency of the LFEP and improvement of its technical-economic characteristics.

The LFEP development being conducted at the Physics Institute and the Institute of High Temperatures is in essence an attempt to unify a completely unconventional heat source -- the laser fusion reactor -- with a standard steam turbine unit series-produced by industry. To this end, a choice was deliberately made in favor of an energy conversion system based on a

Comparison of Experimental Results on the Kal'mar Facility with Theoretical Data Calculated by the Luch Program

Target: radius $R = 70\ \mu m$
wall thickness $\Delta R = 2.2\ \mu m$
deuterium density $\rho = 5.4$ mg/cm

Laser pulse: power $P = 40$ GW
duration $\Delta\tau = 2.5$ ns

Parameters	Experiment	Luch program
Absorbed energy, J	20-25	30
Maximum density of target compression, g/cm^3	6-8	9.7
Plasma ion temperature, keV	—	0.67
Plasma electron temperature, keV	1	0.67
Number of DD reactions	$(3\text{-}6)\cdot 10^6$	$4.4\cdot 10^6$
Implosion velocity, cm/s	$(5\text{-}10)\cdot 10^6$	$8.6\cdot 10^6$
Implosion time, ns	1.6	1.33

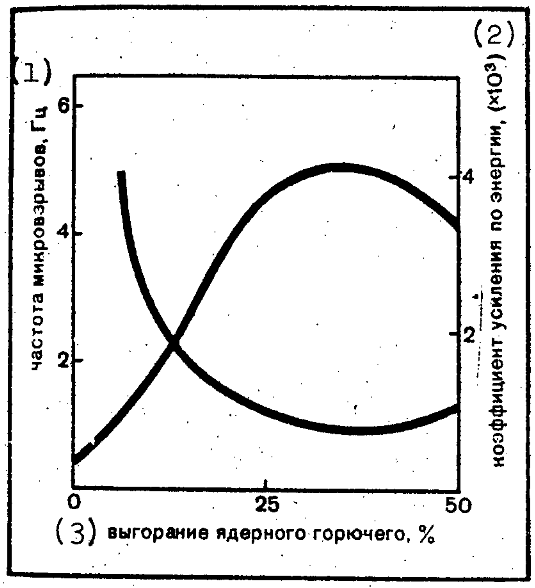
comparatively low-temperature cycle, although the laser-driven fusion reactor is by its nature a high-temperature source. Such a choice limits the amount of nonstandard equipment, and accordingly the number of elements of uncertainty in the planned system.

Technical-economic estimates show that the cost of a kilowatt-hour on the LFEP depends most appreciably on the capital expenditures for the laser system. Apparently this index is on a level of the cost of a kilowatt-hour on facilities with fast breeder reactors, and is twice the cost of a kilowatt-hour on series-produced nuclear electric plants.

PLANS FOR A HYBRID REACTOR AND ELECTRIC PLANT

In our opinion, the most promising is a hybrid version of the reactor in which fissile materials are used in the blanket. In this case, by using fission energy it is possible either to relax the requirements for the laser system (in particular to reduce the efficiency to 0.2% or to lower the pulse energy), or to extend the duration of operation of the entire system (reduce the pulse frequency), or to simplify the design of the laser target (reduce the equipment cost). A hybrid reactor can start operation on low-enrichment fuel (such as natural uranium); in this connection, uranium fission under the action of neutrons emitted in thermonuclear fusion will lead to accumulation of plutonium in the blanket, i. e. the reactor will be a producer of nuclear fuel.

The plan for an electric power plant being developed jointly by the Physics Institute and the Institute of High Temperatures uses a hybrid laser-driven reactor; the energy in a pulse of laser emission is taken as before, but the



Time change in characteristics of the hybrid laser-driven fusion reactor for fixed power of the electric plant
1--Frequency of micro-explosions, Hz
2--Energy gain ($\times 10^3$)
3--Burnup of nuclear fuel, %

laser efficiency is lower (3%), and the target is of a simpler design. This leads to a comparatively low (of the order of 40) energy gain in the thermonuclear micro-explosion. Helium is used as the coolant. It is assumed that the fissile materials should be depleted by 50% and then be buried without any extraction of separate elements or reprocessing. Such a reactor is cylindrical in shape, uses a "wet" wall, and contains 180 metric tons of natural uranium carbide in the blanket.

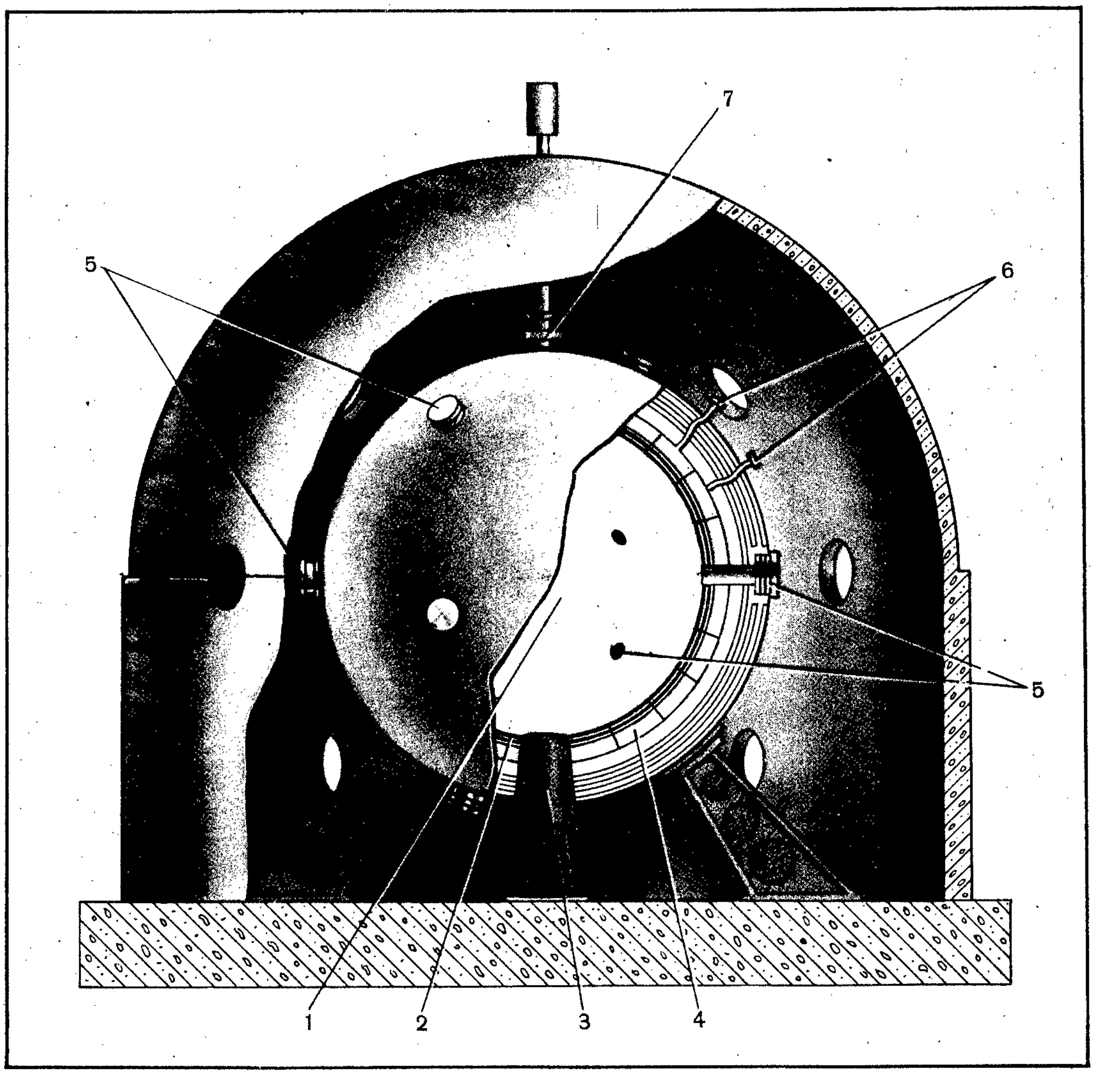
Data on the time dynamics of the main reactor parameters are unusual. It is preferable to have a plant with constant electric power. At the same time, the energy gain in the fissioning blanket is increasing due to plutonium accumulation. This situation can be used to advantage with compensation for the increase in gain by a reduction in the frequency of micro-explosions, and hence extension of the time of operation of the laser system and other systems. The nuclear fuel undergoes a burnup of 50% in approximately 30 years. One of the most serious problems is that over this time period an integrated neutron flux of more than 10^{24} cm^{-2} will be accumulated in the reactor materials, i. e. every atom in the construction materials will experience one or more collisions with neutrons.

In addition to technical-economic estimates, of considerable interest is the examination of problems associated with radioactive wastes, the possible risk in emergency situations, fuel and material resources and so on. It should be noted here that in comparison with breeders, the hybrid reactor has the advantage that it operates in the deeply subcritical mode, and consequently does not require regulation and control of the degree of subcriticality. For this reason, the safety systems will be simpler. Besides, as we have seen, the hybrid reactor in contrast to breeders may operate on fissile materials with any degree of enrichment (for instance on natural uranium), and it has no fuel doubling problems.

Comparison of the Laser-Driven Fusion Electric Plant (LFEP) and the Laser Hybrid Electric Plant (LHEP)

Parameters	LFEP	LHEP
Laser pulse energy, kJ	100	100
Laser efficiency, %	5	3
Energy gain in the target	100	40
Energy release in each thermonuclear micro-explosion, MJ	52	20
Energy gain in the blanket		
at the beginning of a run	—	4
in the middle of a run	—	100
Energy release in fissile blanket materials, MJ		
at the beginning of a run	—	80
in the middle of a run	—	2500
Recurrence rate of micro-explosions, Hz		
at the beginning of a run	10	10
in the middle of a run	10	1
Type of blanket	Homogeneous liquid lithium	Heterogeneous natural uranium carbide with helium coolant
Coolant	Lithium	Helium
Coolant flowrate, kg/s	390	550
Coolant temperature, °C	700	900
Coolant pressure, atmospheres	2	25
Vacuum in explosion chamber, mm Hg	1	1
Duration of operation, years	2	30
Thermal power of reactor, MW	520	2500
Electric power of energy unit, MW	300	1200
Electric efficiency of power plant		
at the beginning of a run	0.33	0.24
after 5 years	—	0.43
after 30 years	—	0.47
Specific capital investment, rub/kW	400	250
Percentage of cost of laser system	40	8
Power production cost, kop/kWh	0.4	0.9

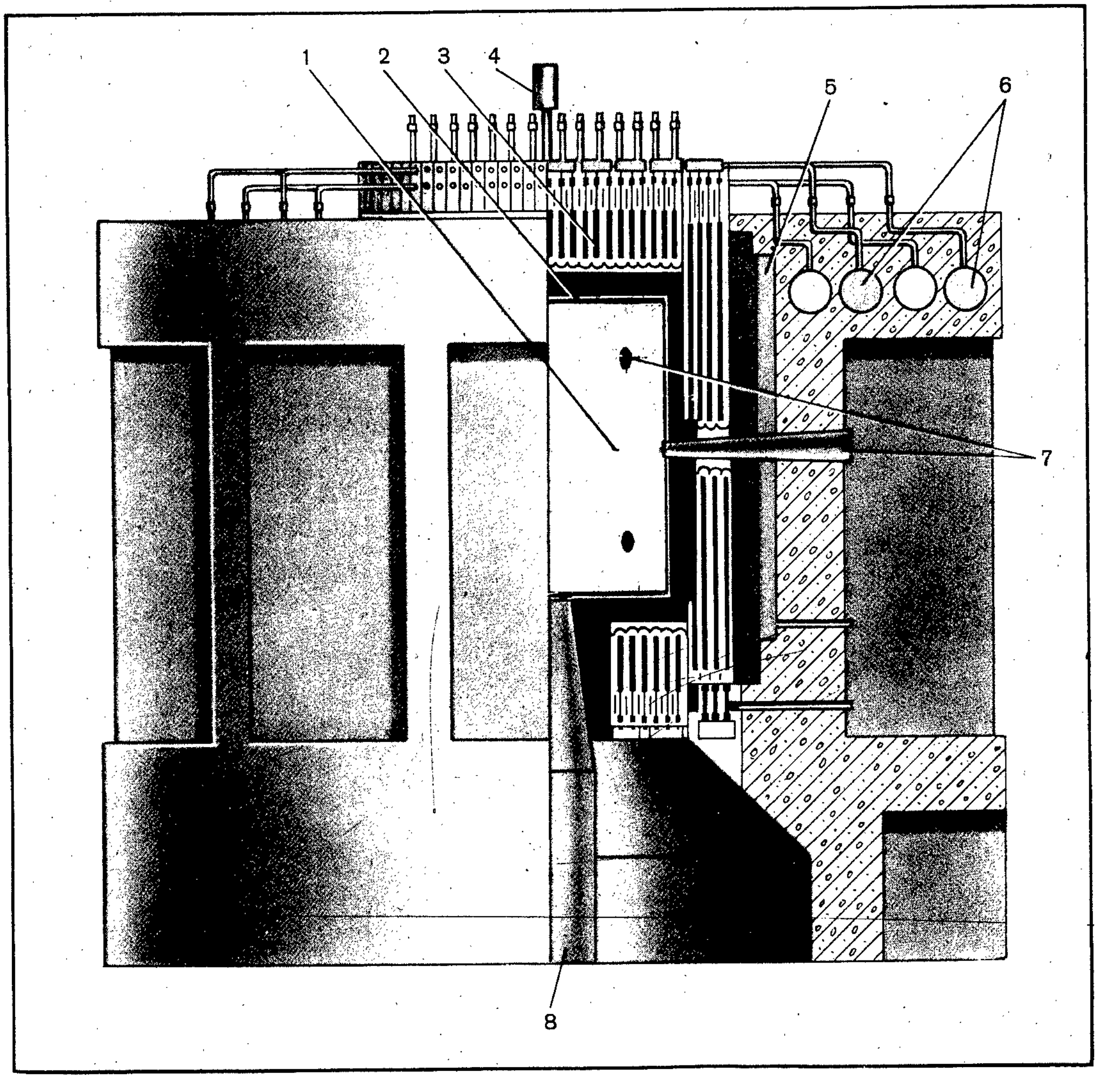
The power of the future must be "variegated" and include various elements in accordance with different demands of the economy. If the laser-driven fusion system is not required to produce electric power, i. e. if we are considering a reactor with zero efficiency used as a neutron source to produce fuel for breeders, it is possible in principle to further relax the requirements for lasers or the thermonuclear yield of targets as compared with the hybrid version. This feasibility is now being intensively studied.



Laser-driven fusion reactor: 1--explosion chamber; 2--porous wall; 3--vacuum port; 4--space filled with lithium (blanket); 5--ports for laser emission; 6--lithium feed; 7--port for introducing the target

Thus we have become convinced that the complicated and multifaceted problem of mastery of fusion power is gradually reaching the stage of scientific and technical development. There is still a lot of work to do on the way; the importance and complexity of the jobs facing scientists and engineers demands a comprehensive approach to the problem as a whole.

However, the outlook for development of a cheap, practically inexhaustible source of power justifies any efforts in this direction, and any success on



Design of the hybrid laser-driven fusion reactor: 1--explosion chamber; 2--porous wall; 3--cartridges with uranium (blanket); 4--port for introducing the target; 5--tritium breeding zone (lithium); 6--coolant (helium) circulation loop; 7--ports for laser emission; 8--vacuum port

the current stage will serve as a powerful incentive for further research and development.

6610
CSO: 1870

PHYSICS

BRIEFS

NEW DISCOVERY IN PHYSICS--A scientific discovery in the field of elementary particle physics has been registered with the USSR State Committee on Inventions and Discoveries. V. Zinov, A. Konin, and A. Mukhin, who are scientists at the Joint Institute for Nuclear Research in Dubna, experimentally determined that extreme changes result in the structure of X-ray spectra of various substances that were subjected to radiation by the elementary particles - muuons. The results of the basic experiments have a practical significance. This discovery gives researchers a new method of examining the composition and chemical bonding of elements, without destruction of the test sample. [Excerpt] [Moscow MOSKOVSKAYA PRAVDA in Russian 9 Jul 78 p 1]

CSO: 1870

SOVIET PHYSICISTS APPLAUD AMERICAN PLASMA SUCCESS

Moscow TASS in English 1350 GMT 17 Aug 78 LD

["Soviet Physicists Congratulate American Colleagues on Their Success"--TASS headline]

[Text] Moscow August 17 TASS--Soviet physicist Academician Boris Kadomtsev said that his colleagues of Princeton University had scored a major success in taming thermonuclear synthesis. Using an experimental reactor, the American physicists obtained a plasma at a temperature of more than sixty million degrees Centigrade.

"It is an important result, an outcome of the research programme being carried out by American physicists for many years," a TASS correspondent was told by Kadomtsev. Work on the same programme is being done by scientists in many countries of the world, including Soviet experts. The ultimate goal of the programme is to provide an actually inexhaustible energy source.

The TASS correspondent was received by the academician precisely at the time when he was signing a congratulatory telegram addressed to Princeton University. "Soviet scientists and myself wholeheartedly congratulate our American colleagues on their great success," he said.

Academician Kadontsev noted that the Princeton thorium plant, which was used for obtaining high-temperature plasma, does not differ in principle from the Soviet Tokamak-10, in which similar experiments have been carried out for a number of years.

"American experts note that the fundamental principles of such plants have been for the first time developed by Soviet scientists," the academician said. He recalled that two years ago American and Soviet scientists succeeded in achieving in these plants a plasma temperature of more than 10 million degrees Centigrade. To achieve a sharp increase in temperature (60 million degrees) the American colleagues used an atom injector, the Soviet academician explained.

"To achieve full control of thermonuclear synthesis," Kadomtsev said, "it is necessary to meet two condition: raise the plasma temperature of up to

60 million degrees, which the American researchers have succeeded to do. The second condition is to prolong the lifespan of plasma." So far, it lives nearly a second in the plant. It ia already a great success for the Soviet and American physicists. But it is not yet possible to prolong the "lifespan" of high-temperature plasma.

The successes of physicists in this direction, the scientist noted, must lead to the creation of thermonuclear reactors generating unlimited quantities of electric power.

But it is still too early to speak about the practical use of the results of research into taming thermonuclear reaction.

CSO: 1852

SOBOLEV, VLADIMIR STEPANOVICH CELEBRATES 70TH BIRTHDAY

Kiev GEOLOGICHESKIY ZHURNAL in Russian V 38, No 4, 1978 p 152

[Article by I.S. Usenko, I.L. Lichak, I.B. Shcherbakov: "An Outstanding Scientist"]

[Text] On 30 May one of the great Soviet geological scientists, Vladimir Stepanovich Sobolev, marks his 70th birthday.

The work of Academician V.S. Sobolev in the fields of petrography of magmatic and metamorphic rocks, theory of metamorphism, crystal chemistry, mineralogy of the rock-forming minerals and experimental minerology has gained wide recognition among geologists and for a long time has received international fame.

In 1936-1937 V.S. Sobolev conducted scientific research on behalf of TsNIGRI [the Central Scientific Research Institute of Geological Prospecting] in the Ukraine in the region of development of the Korostenskiy pluton rocks. The results of this research were published after the Second World War in the classic monograph "Petrografiya vostochnoy chasti Korostenskovo plutona" [Petrography of the Eastern Part of the Korostenskiy Pluton] (1947). This work brought a new understanding of the geology and petrography of the Korostenskiy pluton, and furthermore it became the starting point for the study of similar formations in other regions of the USSR. V.S. Sobolev explained the origin of the rocks of the pluton from the point of view of the theory of crystallization differentiation of the basic magma.

From 1945 through 1958 Vladimir Stepanovich worked in L'vov, where he headed the Department of Petrography at the University and the Division of Petrography at the Institute of Geology and Geochemistry of Combustible Materials of the Academy of Sciences of the Ukrainian SSR. During this period, as the head of his research group, V.S. Sobolev studied the magmatism of the Carpathians, and as a result of this a series of publications appeared, outlining the vulcanism in the Soviet Carpathians and

the petrography and minerology of the vulcanogenic rocks. It was during the Ukrainian period that V.S. Sobolev formulated the composition-state diagrams for some minerals of complex composition, such as biotite, horn-lende blende and pyroxenes; these diagrams became extraordinarily popular in connection with the development of the paragenetic analysis-chemical bases of petrography and the Fedorovskiy method, and also the monograph Vvedeniye v mineralogiyu silikatov" [Introduction to Silicate Minerology"] (1949), for which he was awarded the State Prize. In 1951 Vladimir Stepanovich was elected mimber-correspondent of the Academy of Sciences of the Ukrainian SSR. V.S. Sobolev deserves major credit for the discovery of diamond deposits in Siberia. In 1936 in "Petrografiya trappov Sibirskoy platformy" [Petrography of the Traps of the Siberian Platform], Vladimir Stepanovich theoretically demonstrated the possibility of finding diamonds there, and afterwards he actively defended his views.

In 1958, having been elected an active member of the Academy of Sciences of the USSR, V.S. Sobolev became an organizer of the Siberian Department of the USSR Academy of Sciences. Here he gave his main attention to experimental mineralogy and development of the theory of metamorphism. For a series of works on metamorphism and compilation of a map on metamorphism for the USSR, V.S. Sobolev and his students were awarded the Lenin Prize in 1976.

Academician V.S. Sobolev leads a large scientific organizational and pedagogical effort as chairman of the All-Union Petrographic Committee, president of the International Mineralogical Association, member of many committees and commissions. He is the scientific editor of many monographs. Students of V.S. Sobolev include world-famous scientists, Lenin Prize laureates, and many doctors and candidates of the sciences. Academician V.S. Sobolev has been decorated with the Orders of Lenin and the Worker's Red Banner. The title Hero of Socialist Labor has been conferred on him. On his 70th birthday Vladimir Stepanovich is in the flower of his creative powers, full of energy, new undertakings and ideas.

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